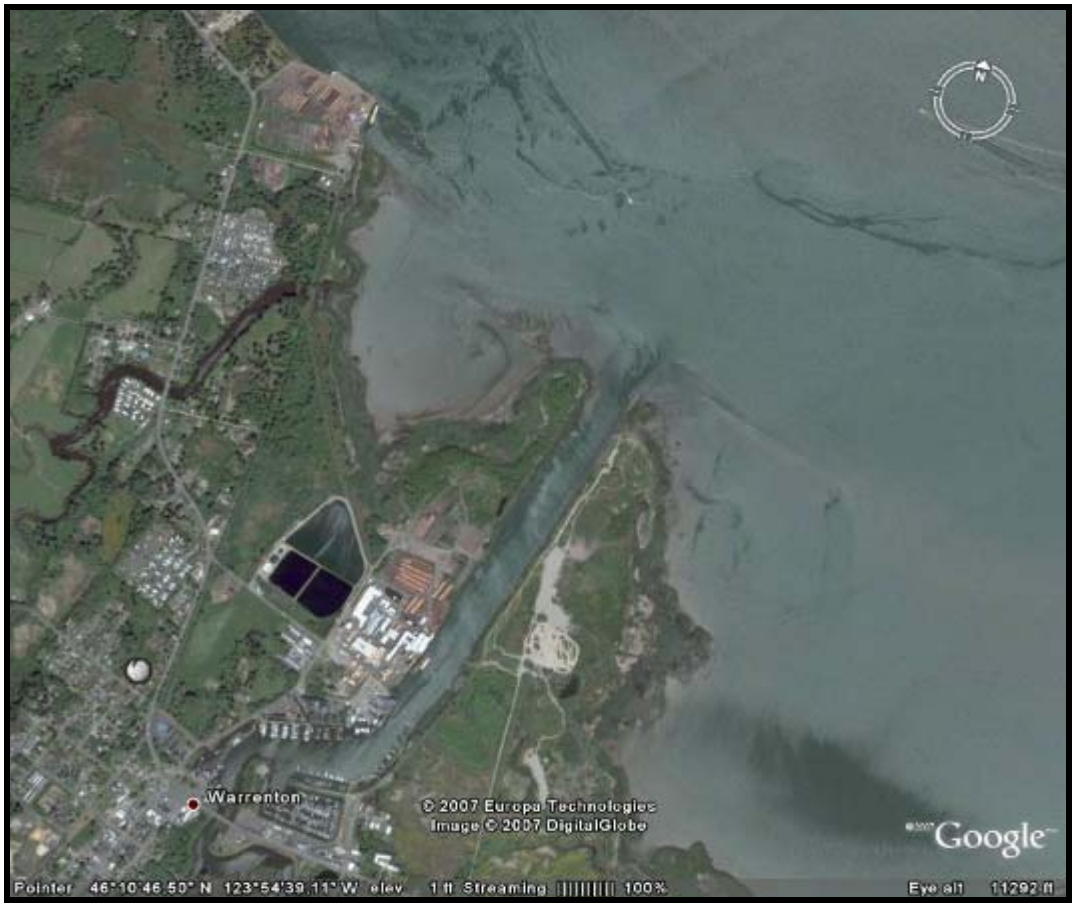
SENSITIVE SECURITY INFORMATION

WATERWAY SUITABILITY ASSESSMENT (WSA) FOR THE PROPOSED OREGON LNG RECEIVING TERMINAL IN WARRENTON OREGON



MARCH 2008

Halcrow

WATERWAY SUITABILITY ASSESSMENT (WSA) FOR THE PROPOSED OREGON LNG RECEIVING TERMINAL IN WARRENTON OREGON

MARCH 2008

Prepared by:

Halcrow, INC

560 Herndon Parkway, Suite 330

Herndon, VA 20170

EXECUTIVE SUMMARY

This Waterway Suitability Assessment ("WSA") was conducted in accordance with the guidelines established in the USCG Navigation and Vessel Inspection Circular ("NVIC") 05-05, "Guidance on Assessing the Suitability of a Waterway for Liquefied Natural Gas (LNG) Marine Traffic" dated 14 June 2005. It is intended to provide the Captain of the Port ("COTP") Portland, OR the information needed to determine whether the waterway is suitable for the proposed facility. Accordingly, the WSA addresses the adequacy of the waterway for navigation, the risk to public safety, what risk management strategies can be employed to mitigate the risk to an acceptable level, and the impact on commercial shipping and other users of the waterway.

The Oregon LNG Company plans to develop, construct, and operate a liquefied natural gas ("LNG") receiving, storage, and re-gasification facility located on the East Skipanon Peninsula (ESP) near the confluence of the Skipanon and the Columbia Rivers in Warrenton, Clatsop County, Oregon ("LNG Terminal"). The proposed LNG Terminal would be located on the northern portion of the ESP at approximately River Mile 11.5 (statute miles) of the Columbia River within an approximately 96-acre parcel of land that is owned by the State of Oregon and leased to the Port of Astoria by the Oregon Department of State Lands. Oregon LNG holds a long term sub-lease for the entire parcel of land. The receiving portion of the LNG Terminal will consist of a single pier, unloading facilities, and pipeline transfer facilities from the pier to the LNG storage tanks to be located on the adjacent land. The LNG Terminal will be connected to the existing interstate pipeline system via a new LNG pipeline extending from the LNG Terminal.

To determine the adequacy of the waterway for navigating ships of the size proposed by Oregon LNG (Q-MAX approximately 263,000 to 266,000 cubic meters) for use at the LNG Terminal, a track line to the proposed terminal site was developed with the assistance of the Columbia River Bar Pilots. The waterway along the route was analyzed for tides, currents, typical weather throughout the year, obstructions, aids to navigation, warning and danger zones, population centers, and other marine traffic that would be encountered. No navigation issues were identified that would prevent LNG ships from transiting safely to and from the LNG Terminal. Ships of comparable size to those being proposed for the LNG Terminal already transit the Lower Columbia River, and the Columbia River Bar Pilots were very comfortable with the idea of navigating

LNG ships to the Terminal Site. The largest LNG ships expected to call at the LNG Terminal might be slightly longer and have wider beams than ships currently transiting the area, but they would not be the deepest draft ships to transit the Lower Columbia River.

Halcrow's research of current and past commercial ship traffic density determined that the additional ship traffic would not be a burden on the Lower Columbia River between the sea buoy and the proposed terminal site. The number of ships crossing the Columbia River Bar and transiting the Lower Columbia River has dropped since the 1990's. The average number of vessels crossing the Bar each month for the period from 1992 – 1999 was 342 while the average number of vessels crossing the Bar since 2000 is only about 294. The additional projected 2 – 3 LNG vessels per week can be accommodated by the current waterway system.

With respect to safety and security issues, the NVIC directed the use of the Sandia National Laboratories ("Sandia"), "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill over Water" Report as the best available information on LNG spills. "Zones of Concern" were identified as the measure of danger to the public should a major LNG spill occur. These zones indicate levels of radiant heat from a burning LNG pool fire or potential danger from an LNG vapor cloud without ignition.

The Sandia Report was based on LNG vessels of approximately 148,000 cubic meters in capacity which was the largest size LNG vessel in service at the time. Since the publication of that Report, much larger LNG vessels have been designed and are currently being built. Sandia has been contracted to update their report and "Zones of Concern" to include the larger LNG vessels. The draft report is complete and currently undergoing agency review.

This Waterway Suitability Assessment (WSA) was expanded to anticipate the results of the new Sandia Report and resulting Coast Guard policy for the new "Q-Max" LNG ships. The draft Sandia Report addressing the larger size LNG vessels reportedly found that the new ship/cargo tank sizes resulted in less than a ten percent (10%) increase in the size of the potential liquid pool/fire danger zones over the 2004 Study results. Therefore, Halcrow included in this WSA, not only the current Zones of Concern defined in the original Sandia Report and NVIC 05-05, but also "Expanded Zones of Concern" to address the larger size vessels. The "Expanded Zones of

Concern" are twelve percent (12%) larger than the current Zones of Concern, significantly larger than the "less than 10 percent larger" zones expected in the new Sandia Report. If the revised Coast Guard guidance is within the Zone sizes used in this report, COTP Portland may choose to approve the use of the larger ships by Oregon LNG based on information in this WSA.

A methodical risk assessment process was completed with the assistance of members of the Portland, OR Area Maritime Security Committee ("AMSC") to review numerous accidental and intentional scenarios. While the risk of an accident can never be completely eliminated, the safety records of the LNG shipping industry and of the Columbia River Bar Pilots are both exemplary. The only accidental scenarios that the Sandia Report determined could potentially result in the release of LNG cargo were a high speed collision with another large vessel or grounding on an outcropping at least 2 meters in size. Both of these scenarios were given special attention in the Safety section of the Risk Assessment. Sandia also identified a number of potential intentional acts which could result in the release of the LNG cargo. Again each of these scenarios, plus several others, were addressed in detail. Of note, the U.S. 2000 Census indicates that the City of Warrenton has a "low population" density of less than 1,000 persons per square mile. As a result of the recommendations of members of the AMSC during the Risk Assessment Workshop held in Warrenton, portions of the City of Warrenton and the Cape Disappointment and Fort Stevens State Parks were treated as medium density populations during the busy summer season in the Risk calculations. Finally, competing interests between the need for security and the impact on the local commercial shipping and boating public were also considered in developing recommendations.

Recommendations

This report recommends a number of risk mitigation measures including safety and security boardings, commercial tug escorts, electronic surveillance, restrictions on commercial and public activities, positive control measures, and education programs for local communities. The risk management strategies that create the most potential impact on other port users are the establishment and enforcement of moving security zones around arriving LNG ships and a fixed security zone around the waterside area of the Terminal Site.

It is recommended that COTP Portland establish a moving security zone around loaded LNG ships transiting the entire Area of Responsibility ("AOR") consistent with the security zone regulations already in place for cruise ships (33CFR 165.1318). These regulations establish a 500 yard security zone around cruise ships with a provision allowing vessels to get as close as 100 yards of the cruise ship if they are proceeding at the minimum speed necessary to maintain navigation. More stringent security zones are recommended at higher MARSEC Levels.

It is further recommended that a fixed security zone be established around the waterside area of the Terminal Site to be in effect at all times. Different size security zones are again recommended for each MARSEC Level.

Conclusion

If the suggested risk management strategies are implemented, the risk of operating an LNG storage facility and transporting LNG to it by ship should be considered acceptable. It is recommended that the COTP for Portland, OR find the Lower Columbia River Waterway from the sea buoy to the proposed Terminal site on the Skipanon Peninsula suitable and recommend approval of same to FERC.

WSA FOR THE PROPOSED OREGON LNG
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1. INTRODUCTION

Oregon LNG, which is headquartered at 8100 NE Parkway Drive, Suite 165, Vancouver, WA 98662, proposes to develop, construct, and operate a liquefied natural gas (LNG) receiving, storage, and re-gasification facility (LNG Terminal) on the East Skipanon Peninsula (ESP) near the confluence of the Skipanon and the Columbia Rivers within the city limits of Warrenton, Clatsop County, Oregon. The proposed LNG Terminal would be located on the northern portion of the ESP at River Mile 11.5 (statute miles) of the Columbia River within an approximately 96-acre parcel of land that is owned by the State of Oregon and leased to the Port of Astoria by the Oregon Department of State Lands. Oregon LNG holds a long term sub-lease for the entire parcel of land.

The receiving portion of the LNG Terminal will consist of a single pier, unloading facilities, and pipeline transfer facilities from the pier to the LNG storage tanks to be located on the adjacent land. The Project will be designed with a natural gas 'send out' capacity of 1.0 billion standard cubic feet per day (Bcf/d) and a peak of up to 1.5 Bcf/d. The project will receive LNG discharged from oceangoing LNG carriers, which will be stored in three (3) 160,000 cubic meter (m^3) above ground, full containment LNG storage tanks. LNG will be vaporized into natural gas, and sent out from the Terminal via pipeline. Approximately 2 to 3 vessels per week are anticipated to call on the Terminal for a total of up to 150 ship visits per year. If the waterway is determined suitable for the new Q-Max size vessels of up to 266,000 cubic meters, only 1 to 2 ships per week will call on the new terminal.

Under Section 3 of the Natural Gas Act (15 U.S.C. § 717), as amended pursuant to Section 311 of the Energy Policy Act of 2005, the Federal Energy Regulatory Commission (FERC) has exclusive authority for authorizing the site location and construction of onshore LNG facilities. As such, FERC is required under the National Environmental Policy Act (NEPA) to complete an environmental review, which is normally documented in the form of an Environmental Impact Statement (EIS). In accordance with a February 2004 interagency agreement between the FERC, the U.S. Coast Guard (USCG), and Research & Special Programs Administration for the Safety and Security Review of Waterfront Import/Export Liquefied Natural Gas Facilities, the USCG acts as a cooperating agency to FERC to provide input for the EIS, serving as the subject matter expert for maritime safety and security.

To meet its responsibility, the USCG promulgated "Navigation and Vessel Inspection Circular No. 05-05 – Guidance on Assessing the Suitability of a Waterway for a Liquefied Natural Gas (LNG) Marine Traffic" (NVIC 05-05) dated June 14, 2005 to provide updated guidance to applicants seeking permits to build shore-side LNG terminals. Under this process, applicants must submit a Letter of Intent (LOI), a Preliminary Waterway Suitability Assessment (PWSA), and then a Follow-on Waterway Suitability Assessment (WSA) to the cognizant Coast Guard Captain of the Port (COTP). The COTP will review and validate the WSA and then provide a Waterway Suitability Report (WSR) to FERC for inclusion in the EIS. Upon completion of the EIS, the USCG will issue a Letter of Recommendation (LOR) to the applicant with the final determination as appropriate.

The LOI and PWSA were submitted to the Coast Guard COTP Portland, OR on May 23, 2007. This report constitutes the follow-on WSA required in NVIC 05-05. It addresses the safety and security issues involved with the LNG vessel while it transits from the 12 mile territorial limit up the Columbia River to the Oregon LNG Terminal Site. The ship track line examined extends approximately 21.6 nautical miles (nm) from the 12 mile territorial sea to the mooring. The report follows the WSA format outlined in NVIC 05-05:

- Port Characterization
- Characterization of LNG Facility and LNG Tanker Route
- Risk Assessment (Safety and Security)
- Risk Management Strategies
- Resources Needed for Safety Security, and Response
- Conclusions and Recommendations

A number of individuals and organizations at the local, state, and federal level were contacted to gather information to “characterize” the port and tanker route. While the primary focus of the risk assessment part of this report is on the immediate area of the ship transit and terminal site, a broader view is taken in the port characterization sections to include examination of potential impacts on other waterway users that need to transit past the terminal and through this area. All deep draft vessels servicing the deep water ports in the lower Columbia River will pass this terminal on their way further up river. Therefore, any impediment to the access to the ship channel is considered in this report.

Oregon LNG is seeking approval to receive LNG vessels of up to the new Q-Max size vessels, approximately 266,000 cubic meters. The current guidance provided by the Coast Guard, NVIC 05-05, which is based on the Sandia Report, SAND2004-6258, only addresses vessels of up to 148,000 cubic meters. These were the largest LNG vessels in operation at the time the Sandia Report was completed. As discussed in Section 3.5 of this WSA, a second Sandia Report is being conducted to analyze the new larger (Q-MAX) LNG vessels currently being constructed. Mr. Ryan and Mr. Glover contacted Mr. Mike Hightower from Sandia to determine the status of the second Sandia Report and what the Zones of Concern will be for the larger LNG vessels. Mr. Hightower informed Mr. Ryan & Mr. Glover that the second Sandia Report is still undergoing internal review and that the new Zones of Concern recommended in the second Study are less than 10% larger than the existing Zones of Concern. Mr. Ryan and Mr. Glover then spoke with LT Shad Scheirman from Sector Portland Oregon and proposed using "Expanded Zones of Concern" that were 12% larger than the existing Zones of Concern. The intent of using the "Expanded Zones of Concern" was to expedite the approval process to receive the new larger Q-Max LNG vessels. LT Scheirman agreed to the inclusion of both the existing Sandia Zones of Concern and the proposed "Expanded Zones of Concern" in the Waterway Suitability Assessment. LT Scheirman further agreed that if the new Sandia Report Zones of Concern are within the 12% increase, and if Coast Guard Headquarters also adopts Zones of Concern that are within the 12% increase, it would be reasonable for the COTP Portland to use the information in this WSA as the basis for the decision regarding the suitability of the waterway for vessels of up to approximately 266,000 cubic meters.

The WSA project was completed by Captain Scott J. Glover, (U.S.C.G. ret.) and Captain David Ryan, (U.S.C.G. ret.). They have the appropriate skills as required by 33 CFR 103.410. Scott Glover is the Director of Halcrow's Maritime Security Program. Members of his team have conducted maritime security assessments and maritime security training in a number of ports in the world. Captain Glover and Captain Ryan conducted the Waterway Suitability Assessment for the proposed LNG receiving terminal at Sparrow's Point, Maryland. Capt. Scott Glover (Ret.) has 22 years of Coast Guard Maritime Safety and Security experience as well as five years sea service and holds a First Assistant Engineer license with the STCW endorsement. Capt. David Ryan (Ret.) has 30 years Coast Guard experience including command of several major Coast Guard cutters. Both individuals have extensive risk-assessment experience and knowledge of the maritime industry. Their resumes are attached in Appendix S.

2. PORT CHARACTERIZATION

The proposed Oregon LNG Terminal site is located near the mouth of the Columbia River approximately 1.5 miles down river from the Port of Astoria, OR, the nearest deep water port. The project site is within the city limits of Warrenton, OR and also within the Port of Astoria district. Because of its location near the mouth of the Columbia River the impact of the proposed terminal is much broader than just the localized port area. The Columbia/Snake River maritime transportation system (MTS) involves vessel traffic bound for or originating from other ports outside of the river system, including both U.S. and international ports, as well as a vibrant intra-river system trade. Any impact on commercial vessel traffic transiting the navigation channel down river of the Astoria-Megler Bridge, passing the terminal, affects the Columbia/Snake River MTS. Therefore, the "Port Characterization" section of this report addresses potential impacts on both the Port of Astoria district and the vessel traffic transiting the Columbia River navigation channel below the Astoria-Megler Bridge.

2.1 THE PORT OF ASTORIA

The Port of Astoria is the first deep-draft port available upon entering the Columbia River. The Port maintains nearly 7,250 feet of total dock space on three piers. These piers and the adjacent property are dedicated to marine-dependent commercial and industrial activities.

The northern face of the most easterly of the terminal piers, Pier 1, serves as a cruise ship berth for many of the major cruise lines. It also accommodates general cargo, military and industrial vessels up to 1,100 ft. Section 2.5 of this report will address the cruise ship industry in Astoria in more detail. The west face of Pier 1 is the permanent mooring for the Oil Spill Response Vessel (OSRV) Oregon Responder which is owned and operated by the Marine Spill Response Corporation (MSRC).

The northern face of Pier 2 is approximately 425 feet long and provides another location for transient vessels. It is currently in need of repairs, but the Port intends to repair and make it fully functional again once funding has been identified. The east face of Pier 2 serves the bulk of the commercial fishing needs of port users with its 71,800 $ft.^2$ multi-tenant building. Seafood processors Astoria Pacific Seafood, Westbay Marketing, and Da Yang Seafood are located on the pier. Bornstein's Seafood is

located at the head of slip 1, which is the slip between Pier 1 and 2. Pier 2 provides commercial fishing fleet support via fish off-loading and fish net haul-out areas.

In addition, the motor vessel (M/V) Salvage Chief is homeported in Astoria and moors on the east face of Pier 2. The ship is owned by Fred Devine Diving & Salvage Company in Portland. It is approximately 202 feet long with significant salvage capabilities.

Pier 3, the Port of Astoria's most westerly pier, has an 88 ton Travel Lift and serves as a haul-out/boatyard facility for both recreational and commercial boats. At present, the city fireboat, the M/V Harry M. Steinbock, is hauled out of the water in the boatyard in a state of disrepair.

Photo 2-1 Port of Astoria

2.2 CITY OF WARRENTON

The location of the proposed terminal site is within the city limits of Warrenton, Oregon. While not a major deep water port on the Columbia, there is a large marina located on the Columbia River and another marina in the Skipanon Waterway. There are two businesses near the proposed terminal that use tug/barge traffic to transport cargo.

Weyerhaeuser has a saw mill facility that employs approximately 140 people located on the west side of the Skipanon River with an address of 550 NE Skipanon Drive, Warrenton, OR 97146. The plant requires periodic tug and barge traffic to transport wood chips further up the Columbia River. The Weyerhaeuser plant buildings are approximately 1400m from the LNG ship berth.

Warrenton Fiber is a wood chip facility located at the eastern tip of Tansy Point that employs approximately 50 people. They have a 750 foot pier where tugs deliver barges with logs to process and depart with barges that are loaded with chips. Tugs deliver logs to be processed by the mill, bringing them into the Columbia River after a coastal transit from other ports in Oregon and Washington. Tugs also transport barges loaded with wood chips up the Columbia River. The dock face is 1500 feet long capable of handling oceangoing ships. According to Mr. Steve Fulton at Warrenton Fiber, they are actively looking for commercial uses for its available dock space and property. The dock at Tansy Point is approximately 2000 yards (1828 meters) from the proposed LNG berth.

Between Warrenton Fiber on Tansy Point and Hammond marina are a number of businesses and residences along the shore of the Columbia River that face the shipping channel. Moving north along the shore, or down river, from Warrenton Fiber is a short road with a number of private residences, then a building that houses Carruther's Equipment Company, then Bio Oregon Protein, some private residences (houses), the Point Adams Packing plant that includes a pier sticking out towards the shipping channel, a few more houses, then the Point Triumph condominiums which include 27 condos and one single residence building, before reaching the Hammond Marina basin.

North of the Hammond Marina is a small waterfront park and a parking area with approximately 20 parking spaces for self contained vehicles to use for camping. The spaces are administered by the marina.

2.3 THE COLUMBIA/SNAKE RIVER MARINE TRANSPORTATION SYSTEM

"The Columbia/Snake River System and the Oregon Coastal Cargo Ports region is a critical regional and national gateway linking agricultural, mineral and goods production across the Northwest, Midwest and Mountain states to growing markets in the Pacific Rim. With water grade rail routes through the Cascade Mountains, this system is the least-cost barge and rail route for this traffic to reach deep water shipping, where ocean transit to Asia is one day faster than from California and 10 days faster than from the U.S. Gulf. This MTS (Maritime Transportation System) is particularly important to the global competitiveness of one of America's strategic industries – grain production. The Columbia River is the leading export gateway for U.S. wheat and barley. Pacific Northwest grains are competitive in Asia largely by virtue of the low-cost

rail and barge routings available via the Columbia River corridor. The Columbia River/Snake River/ System and Oregon Coastal Cargo Ports region is the leading bulk cargo and forest products trade gateway of the West Coast."[1]

Table 2-1
Columbia/Snake River System Grain Rankings

Commodity	Ranking	Percent of Exports
Wheat	#1 in US	37%
Barley	#1 in US	97%

The Columbia/Snake River System and Oregon Coastal Ports Marine Transportation System consist of three interrelated systems; the lower Columbia River deep draft ports, the Columbia/Snake River inland ports and the Oregon coast deep draft ports.

2.4 LARGE COMMERCIAL TRAFFIC ON THE LOWER COLUMBIA RIVER

The term "Lower Columbia River" is used in this report to refer to the section of the Columbia River stretching from the mouth upriver 103.5 miles to the end of the dredged deep water navigation channel at Portland/Vancouver. As discussed above, the Lower Columbia River is a key regional and national gateway linking agricultural, mineral and goods production across the Northwest, Midwest and Mountain states to growing markets in the Pacific Rim. In 2004, ocean-going vessels on the Columbia River transported $16 billion worth of U.S. products to and from world markets. The commodities these ships carry include millions of tons of grains, mineral bulks such as potash and soda ash, breakbulks such as steel and forest products, automobiles from Honda, Toyota, Hyundai and Subaru, and containerized freight such as clothing, electronics, animal feed and paper products. [2] There are six lower Columbia River Ports; Portland and St. Helens in Oregon; and Kalama, Longview, Vancouver and

[1] "Columbia/Snake River System and Oregon Coastal Cargo Ports Marine Transportation System (MTS) Study." Center for Economic Development Education and Research. June 2005. Page 3.

[2] Portland Port Authority Web Site http://www.portofportland.com/ch_home.aspx

Woodland in Washington. Portland and Vancouver are responsible for handling the majority of the cargo.

The number of ships crossing the Columbia River Bar has dropped since the 1990's (Table 2-2). The average number of vessels crossing the Bar each month for the period from 1992 – 1999 was 342 while the average number of vessels crossing the Bar since 2000 is only 294.

Table 2-2
Columbia River Bar Monthly Traffic [3]

COLUMBIA RIVER BAR MONTHLY TRAFFIC

1992 – 2007

MONTH	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	AVERAGE 2002-2007
Jan	301	339	335	303	347	336	331	345	323	342	286	249	280	268	256	271	268.3
Feb	363	347	329	380	305	318	309	302	328	319	268	237	297	245	270	292	268.2
Mar	359	343	341	366	346	359	316	328	337	303	272	281	301	276	277	303	285.0
Apr	353	368	365	355	308	315	309	320	377	334	260	290	267	244	254		263.0
May	338	367	355	342	342	323	339	368	366	326	261	298	306	272	290		285.4
June	349	294	358	341	302	331	341	339	342	293	293	285	315	258	321		294.4
July	341	323	337	363	285	333	289	361	349	300	267	286	258	263	289		272.6
Aug	355	345	348	386	362	325	319	380	344	316	301	315	287	282	309		298.8
Sept	366	345	361	364	337	362	340	343	326	308	289	313	306	286	323		303.4
Oct	386	368	355	406	353	351	375	360	377	325	292	307	315	287	290		298.2
Nov	360	319	393	384	332	353	321	342	324	317	283	327	275	277	271		286.6
Dec	341	350	363	343	298	295	318	333	306	301	277	284	247	263	299		274.0
TOTAL	4212	4108	4240	4333	3917	4001	3907	4121	4099	3784	3349	3472	3454	3221	3449	866	3397.9
AVERAGE	351.0	342.3	353.3	361.1	326.4	333.4	325.6	343.4	341.6	315.3	279.1	289.3	287.8	268.4	287.4	288.7	283.2
Year to Year		-2.5%	3.2%	2.2%	-9.6%	2.1%	-2.3%	5.5%	-0.5%	-7.7%	-11.5%	3.7%	-0.5%	-6.7%	7.1%	7.8%	

Logbook ship numbers

NOTE:

To confirm this information Halcrow evaluated vessel calls at the two largest ports on the Columbia River; Portland, OR and Vancouver, WA. The reduction in vessel traffic noted on the Columbia River Bar Monthly Traffic Report (Table 2-2) is supported by data provided in the Port of Portland web site (Table 2- 3) which indicates that ship visits to the Port of Portland have dropped over the last decade from a high of 1,024 ship visits in 1994 to just 793 ship visits in 2006; a drop of over 22%.

[3] Table 2-2 Columbia River Bar Monthly Traffic data provided by Capt Lewin, Columbia River Bar Pilots

Table 2-3
Port of Portland Marine Terminal Statistics

PORT OF PORTLAND

Port of Portland Marine Terminal Statistics, 1978 - 2006

Calendar Year	Vessel Calls	Total Tonnage	Breakbulk Tonnage	Container TEUs			Automobile Units	Grain Tonnage	Mineral Bulk Tonnage
				Export	Import	Total			
1978	N/A	4,715,677	964,207	48,954	35,067	84,021	226,164	2,387,686	340,079
1979	N/A	6,381,121	1,232,186	52,226	35,592	87,818	249,191	3,584,585	435,499
1980	N/A	7,026,976	1,119,712	51,731	41,284	93,015	266,578	4,419,674	293,873
1981	N/A	7,358,527	900,602	48,086	30,713	78,799	263,117	5,069,467	317,996
1982	N/A	6,482,768	664,011	46,274	26,745	73,019	260,238	4,505,017	327,506
1983	N/A	7,245,779	692,941	64,661	36,350	101,011	270,928	4,751,707	515,420
1984	N/A	8,268,386	804,187	84,211	41,551	125,762	308,884	5,226,227	524,314
1985	901	7,199,961	1,042,349	92,860	45,024	137,884	341,274	3,995,604	326,769
1986	893	7,042,011	916,902	86,669	38,329	124,998	411,608	3,915,913	296,039
1987	916	8,411,108	924,133	99,459	40,116	139,824	373,916	5,053,527	318,857
1988	1,001	9,779,216	1,276,900	115,421	49,175	164,606	392,212	5,292,648	869,217
1989	930	9,226,981	1,171,845	124,304	61,723	186,027	327,522	4,209,716	1,538,542
1990	896	9,498,326	942,443	107,901	55,032	162,933	302,652	4,717,519	1,796,879
1991	983	10,258,314	1,195,345	118,413	57,487	175,900	289,191	4,718,840	2,103,129
1992	1,017	10,768,718	1,050,743	149,075	68,347	217,422	272,958	4,646,490	2,361,791
1993	1,005	10,482,961	834,935	171,664	67,775	239,439	238,300	4,544,028	2,235,615
1994	1,024	11,788,821	666,098	221,142	96,819	317,961	294,145	5,250,964	2,131,859
1995	903	11,996,930	400,836	226,412	103,335	329,747	233,807	5,398,942	2,442,017
1996	818	10,552,558	345,952	200,693	101,478	302,171	204,542	4,160,264	2,575,454
1997	906	10,772,620	411,186	186,633	108,297	294,930	254,650	3,611,323	3,201,482
1998	984	11,330,619	575,179	176,719	82,589	259,308	245,821	3,814,156	3,756,917
1999	985	12,076,889	752,914	206,362	86,900	293,262	308,813	3,660,089	3,958,237
2000	913	11,804,776	644,362	221,481	69,462	290,943	345,772	3,218,310	4,219,040
2001	864	11,052,341	768,661	214,743	63,748	278,491	356,516	2,674,336	4,140,627
2002	800	10,678,519	772,966	200,298	55,447	255,745	394,776	2,628,578	4,032,277
2003	832	11,957,917	704,190	265,756	73,185	339,571	366,383	3,038,142	4,519,256
2004	773	12,581,370	892,115	203,385	71,224	274,609	358,682	3,911,093	4,457,176
2005	684	11,550,062	986,229	95,279	65,200	160,479	354,976	3,849,039	4,552,436
2006	793	11,965,669	1,059,486	124,791	89,693	214,484	463,557	3,705,953	4,319,450

The above figures apply to Port of Portland public terminals. All tonnage is in short tons. Automobiles are measured in number of units, and

Halcrow was only able to find data on vessel calls for the Port of Vancouver, WA for the last three years. Table 2-4, indicates that ship visits to the Port of Vancouver have been relatively steady over this three year period.

Table 2-4
Vessel Calls to Vancouver Washington

Year	No. Vessel Calls	Cargo Tonnage
2004	502	4,602,635
2005	527	3,979,939
2006	526	5,194,208

Although the number of vessels transiting the Lower Columbia River has decreased, two of the studies reviewed by Halcrow, "The Columbia/Snake River System and Oregon Coastal Cargo Ports Marine Transportation System (MTS) Study" and the "Commodity Flow Forecast Update and Lower Columbia River Cargo Forecast" agree that cargo tonnages on the Columbia River have been increasing.

The "Columbia/Snake River System and Oregon Coastal Cargo Ports Marine Transportation System (MTS) Study" states that, "Marine traffic passing the entrance of the Columbia River increased from 18 million tons in 1972 to 32 million tons in 2003 which amounts to annualized growth of 1.8%."[4] The Oregon Department of Transportation chartered Study entitled "Commodity Flow Forecast Update and Lower Columbia River Cargo Forecast" looked at projected cargo flows based on the existing dredged channel of 40 feet and the planned dredging to 43 feet. In both cases the Study showed growing cargo tonnages with a greater increase in tonnages if the channel is dredged.

"The Columbia River deepening project is expected to increase containerized and grain traffic. There may also be a positive impact on break bulk, dry bulk and liquid bulk cargoes as a result of the deepening project. However, these impacts were not included in the analysis. Under "without project" conditions (existing 40-foot navigation

[4] "Columbia/Snake River System and Oregon Coastal Cargo Ports Marine Transportation System (MTS) Study." Center for Economic Development Education and Research. June 2005. Page 4.

channel), the forecast calls for waterborne traffic to reach a level between 33 million tons and 48 million tons by the year 2030, or at average annual rates of -0.4% and +0.8% under low and high growth scenarios between 2000 and 2030, respectively. Under "with project" conditions (improved 43-foot navigation channel), the forecast calls for waterborne traffic to reach a level between 38 million tons and 55 million tons by the year 2030, or at average annual rates of 0.0% and 1.3% under low and high growth scenarios between 2000 and 2030, respectively."[5]

Cargo tonnages have been increasing while the number of vessel transits has been decreasing because the vessels have become much larger. "Economies of scale in marine shipping have driven ship sizes and unit train lengths to be much larger over time, requiring very large cargo volumes to be transferred in a short period of time. The marine cargoes handled in the region are increasingly shipped in Panamax and, in the case of containers, post-Panamx vessels, whereas much of the region's cargo was handled in Handysize and Handymax vessels in the past."[6]

In summary, although greater tonnages of cargo are moving on the Columbia River, it is moving on fewer vessels. As noted above, the average number of vessels crossing the Bar each month has dropped by almost 50 in comparison to the 1990s. Thus the Columbia River maritime transportation system has already demonstrated its ability to handle the proposed 2 – 3 LNG vessels per week (8-12 vessels per month).

Note - The US Corps of Engineers is currently in the process of a major Columbia River improvement project that will deepen the entire existing dredged ship channel from the present 40 foot control depth to 43 feet. The dredging began in 2005 and is expected to be completed by 2008. The dredging is complete in the area of the river mouth and past the proposed terminal site and will not impact or be impacted by the proposed Project.

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[5] Ditto Page 24

[6] "Columbia/Snake River System and Oregon Coastal Cargo Ports Marine Transportation System (MTS) Study." Center for Economic Development Education and Research. June 2005. Page 6.

2.5 CRUISE SHIP AND RIVER CRUISES TRAFFIC ON THE LOWER COLUMBIA RIVER (BELOW THE ASTORIA-MEGLER BRIDGE)

The Port of Astoria is a port call for both major “blue water” cruise ships and the smaller river cruise boats which operate on the Columbia River. The number of large cruise ship visits to Astoria has risen over recent years and attempts are being made by the Port to continue to grow this market.

2.5.1 Cruise Ship Visits

The Port of Astoria is an active member of the Cruise-the-West, a West-Coast cruise consortium whose goal is to increase the volume of cruise ships calling on U.S. Pacific ports. The major cruise ships call on Astoria (and the other West Coast Ports) when they are being repositioned between the Alaska routes in the summer and the Caribbean and Mexican routes in the winter. A variety of cruise lines currently call on Astoria including:

- Holland America
- Norwegian Cruise Lines
- Royal Caribbean Cruise Lines
- Radisson Seven Seas Cruises
- Princess Cruise
- Celebrity Cruise
- The World of ResidenSea

The outer face of Astoria’s Pier 1 is the normal cruise ship berth. If there is more than one cruise ship in Port at the same time the second cruise ship will anchor in the anchorage above the Astoria-Megler Bridge off of the Columbia River Maritime Museum in Astoria. The passengers are then ferried ashore using tender vessels which dock at the museum pier.

Page 20473 of the Federal Register dated April 20, 2005, states, “The Captain of the Port Portland, OR will begin, on May 5, 2005, enforcing a small area of the greater Large Passenger Vessel Security and Safety Zones that were established in September 2003. The zones provide for the security and safety of large passenger vessels in the navigable waters of Portland, OR and adjacent waters. These security and safety zones will be enforced for passenger cruise ships only and only from the mouth of the

Columbia River at buoy 14 upriver to, and including, Astoria, OR until further notice." Discussions with Coast Guard Sector Portland, OR and Group Astoria personnel confirmed that escorts are conducted, at least on a periodic basis, and that the escorts normally consist of 2 small boats or one small boat working with a Coast Guard helicopter. Security patrols are not normally provided by the Coast Guard around moored cruise ships; however, the Clatsop County Sheriffs Department will sometimes provide security patrols around docked cruise ships.

The cruise ships will pass by the proposed LNG terminal when arriving and departing Astoria. The cruise ship berth at Pier #1 will fall within Zone 3 of the Sandia Zones of Concern. The Astoria Anchorage, where cruise ships anchor if Pier #1 is occupied, and the Columbia River Maritime Museum, where the passengers are landed, are both upriver of the Astoria-Megler Bridge, well outside of the Sandia Zones of Concern. (See Appendix A)

Table 2-5 is the cruise ship schedule for Astoria, Oregon for 2007. (Note the cruise ship schedule for 2008 had not been finalized when this WSA was completed).

Table 2-5
2007 Astoria Cruise Call Calendar
(The 2008 cruise ship calling dates are not yet posted)

ARRIVAL #	DAY	DATE	VESSEL	ETA	ETD	BERTH	LINE
1	SUN	22-Apr	Mercury	0700	1600	P1	CELEBRITY CRUISES
2	MON	30-Apr	Mercury	0900	1800	P1	CELEBRITY CRUISES
3	THU	3-May	Norwegian Star	1030	1600	P1	NORWEGIAN
4	FRI	4-May	Oosterdam	0700	1400	P1	HOLLAND AMERICA
5	SAT	5-May	Ryndam	0700	1500	Anchor	HOLLAND AMERICA
6	SAT	5-May	Norwegian Sun	0730	1330	P1	NORWEGIAN
7	MON	7-May	Serenage of the Seas	0900	1800	P1	ROYAL CARIBBEAN

ARRIVAL #	DAY	DATE	VESSEL	ETA	ETD	BERTH	LINE
8	THU	10-May	Diamond Princess	0800	1700	P1	PRINCESS CRUISES
9	THU	10-May	Volendam	0700	1400	Anchor	HOLLAND AMERICA
10	MON	14-May	Seven Seas Mariner	800	1600	P1	RADISSON SEVEN SEAS
11	WED	16-May	Radiance of the Seas	0700	1730	P1	ROYAL CARIBBEAN
12	SUN	23-Sep	Summit	TBA	TBA	P1	ROYAL CARIBBEAN
13	MON	24-Sep	Radiance of the Seas	0900	1700	TBA	ROYAL CARIBBEAN
14	TUES	25-Sep	Golden Princess	0800	1700	P1	PRINCESS CRUISES
15	FRI	28-Sep	Zaandam	0800	1800	P1	HOLLAND AMERICA
16	SAT	29-Sep	Volendam	1000	1800	P1	HOLLAND AMERICA
17	WED	3-Oct	Oosterdam	1100	2000	P1	HOLLAND AMERICA
18	TUES	6-Nov	Mercury	0700	1700	P1	CELEBRITY CRUISES

On March 27, 2007 Halcrow representatives met with Astoria Port and cruise ship representatives Mr. Ron Larson (Port of Astoria, Director of Operations), Mr. Mitch Mitchum (Cruise Ship Coordinator) and Mr. Bruce Conner (Cruise Marketing) and representatives of the volunteer groups which support the cruise ship visits to discuss any possible concerns they would have with an LNG terminal located on the Skipanon peninsula. All in attendance agreed that the only concern they had was that the LNG operations not impact the arrival and departure schedules of the cruise ships. The cruise ships normally arrive at approximately 8:00 AM and depart around 5:00 PM so

the passengers have a narrow window in which to disembark and visit Astoria and the surrounding attractions. The visitors provide an important source of revenue to many of the City's businesses so the vessels arrival cannot be impacted by an arriving or departing LNG ship. Just as importantly, the cruise ships cannot be delayed in departing Astoria as they must arrive in their summer/winter homeports on schedule to pick up their first group of passengers.

Volunteer representatives attending the meeting highlighted the importance of the many volunteers that support the visiting cruise ships. Peter Gearin, the executive director for the Port of Astoria, stated in the April 30, 2006 copy of the Port of Astoria newsletter, "Portways" that, "… it takes approximately 60 volunteers to accommodate each cruise ship that comes to port, and that there are about 140 community members who make up the retinue of available volunteers." Many of the attendees at the meeting were concerned that the volunteer's schedules may not be as flexible with regard to a vessel's arrival or departure being delayed as a paid employee.

2.5.2 River Cruise Boats

Halcrow representatives met with Mr. Jerry Ostermiller, Columbia River Maritime Museum Director, to discuss, among other topics, the river boat cruises that visit Astoria. The major river cruise operators include: the American West Coast Steamboat Company, Adventure Cruises, Cruise West, and the Great American River Journeys.

The river boats vary in size with the larger vessels carrying 200 – 250 passengers. The cruises are normally 1 week long starting at Portland, Oregon with stops along the Columbia and Snake Rivers including Astoria. The river boat cruising season is year round, however, the "2007 Astoria Cruise Call Calendar" (Table 2-5) indicates that the majority of the river cruise boat visits scheduled for Astoria will occur in the Spring through the Fall. (The 2008 schedule was not yet available).

The river boats moor at the Astoria Maritime Museum dock upriver of the Astoria-Megler Bridge, which is well outside of the Zones of Concern for the LNG ships transiting to the proposed terminal and while moored at the terminal. However, a small number of river boats do sail past the Astoria-Megler Bridge to approach the Columbia River Bar close enough to allow the passengers to see the breaking waters on the Bar. These vessels would sail past the proposed LNG terminal.

Table 2-6 provides the number of passengers and number of River Boat ship visits to Astoria for the years 2000 – 2004.

Table 2-6
River Boat Vessel Calls (Astoria) 2000-2004

Year	Passengers	Vessel Calls
2000	20,000	134
2001	25,900	184
2002	21,500	149
2003	20,500	107
2004	19,000	102 (Estimated to-date)[7]

2.6 TUG AND BARGE OPERATIONS

There are fourteen towing companies listed on the Merchants Exchange of Portland website. However, most of those companies provide tug services within the Columbia River and would rarely, if ever, transit by the proposed Oregon LNG Terminal. The Halcrow staff interviewed representatives of several of the major tow boat companies to determine what, if any impact, an LNG operation located on the Skipanon Peninsula would have on their tug operations.

Mr. Rob Rich, of Shaver Transportation Company, stated that he believed three companies routinely provide tug/barge services which transit past the proposed LNG Terminal site - Shaver Transportation Company, Tidewater Barge Lines, and Foss Maritime Company. He estimated that the average number of tug and barge transits that pass the proposed terminal site is 40 per month. That number is based on 20

[7] Astoria Port Web Site

inbound and 20 outbound transits. He emphasized that the numbers will vary depending on the time of year and demands of the port facilities. Mr. Shaver did not express any concerns with the proposed LNG terminal as long as vessels can transit passed the moored LNG vessels.

Mr. Craig Nelson of Tidewater Barge Lines stated that his only concern with an LNG Terminal being built on the Skipanon Peninsula was his ability to move his barges in and out of the Weyerhaeuser and Warrenton Fiber facilities. The Tidewater Barge Lines operates approximately eleven tugs on the Columbia River. However, the only Tidewater tug/barges that operate downriver of the Astoria-Megler Bridge are used to transport saw dust from the Weyerhaeuser Facility on the Skipanon Waterway and wood chips from the Warrenton Fiber Plant on Tansy Point to pulp paper mills upriver. Approximately four to six (4–6) barges are dropped off and picked up each week. The normal routine is for the tug LIBERTY to bring one to two (1–2) empty barges down river and drop off one at each of the facilities and pick up the loaded barges for the return trip. The operation is normally conducted on Monday, Weds and Friday between 0300 and 1200.

Mr. Dick Lauer, Manager of Bulk Products for Sause Brothers, stated that he has a tug and barge passing the proposed LNG terminal site, either up bound or down bound, almost every day. The company provides a number of ocean going barge services on the Columbia River including a Hawaiian Barge service to Oahu providing service every three weeks, a lumber barge service every 21 days and a weekly to bi-weekly tank barge service. The company operates 36 tugs and 25 barges up and down the West Coast. The barges vary in size from 300 – 450 feet in length with drafts of 19-26. The tug and barges are deep water vessels and must navigate within the deep waters of the marked channels on the Columbia River. While navigating the Columbia River the tugs are normally towing the barges. The oil barges will routinely have two tugs with a lead and tag tug. Mr. Lauer's concern with the proposed LNG terminal on the Skipanon Peninsula is that the transit of his vessels not be impacted by the terminal or vessels involved with the terminal operations.

Mr. Bob Shrewbury, of the Western Towboat headquartered in Seattle, WA, stated that the Western Towboat's major route is Washington up to Alaska. The

company has only sporadic work on the Columbia River, averaging a couple times per month. Mr. Shrewsbury was not at all concerned with the prospect of an LNG Terminal on the Skipanon Peninsula. He said everyone talks on Channel 13 and if an LNG was arriving you could simply work around it.

Mr. Mike Walker of Foss Towing expressed little concern with regard to the development of an LNG terminal on the Skipanon Peninsula. He felt that the tugs could readily adjust to the LNG vessel traffic and the related security zones. Foss tug and barges enter the Columbia River and would travel past the proposed LNG terminal about twice a week. He estimated 2 – 3 tug/barge combinations cross the Columbia River Bar each day. However, he emphasized that the number fluctuates widely based on the season and weather. He said that he was more concerned with the location of the proposed LNG Terminal because of the winds in that area rather than its impact on transiting tug boats. He was concerned with the ability of a vessel to remain at the pier if there were heavy winds.

In summary, we estimate that two to three tug or tug/barge combinations currently transit past the proposed site each day. These transits can be anytime during the day or night except for the Tidewater tugs which normally conduct their work at the Weyerhaeuser Facility on the Skipanon Waterway and the Warrenton Fiber Plant on Tansy Point between 0300 and 1200 on Monday, Weds and Friday. The main concern expressed by some of the representatives that we interviewed was that the tugs must be able to transit past the terminal and LNG vessels moored at the facility while remaining in the channel.

In Section 7, Recommendation 7.3(C)(6), Halcrow recommends that at MARSEC 1 the security zone around a moored LNG vessel should extend 200 yards. This size security zone will not impact the movement of vessels in the shipping channel nor will it limit movement in and out of the Skipanon Waterway. Mr. Walker's concern with the adequacy of the LNG vessel's mooring arrangement to handle heavy winds are addressed in Section 3.1.2 and Recommendation 7.3(E)(1).

2.7 PILOTAGE

Pilotage by the Columbia River Bar Pilots is mandatory for all arriving and departing LNG vessels. Volume #7 of the United States Coast Pilot dated 2007 states:

> "Pilotage across the Columbia River bar and up or down the river is compulsory for U.S. vessels enrolled or sailing under Registry and all foreign vessels, except foreign recreational or fishing vessels not more than 100 feet in length or 250 gross tons international... Pilotage is provided by the Columbia River Bar Pilots for the river entrance, from the open sea in at least 30 fathoms of water to the easternmost wharf at Astoria, and by the Columbia River Pilots from the westernmost wharf at Astoria to the head of navigation on the Columbia or Willamette Rivers and their tributaries." [8]

Embarking and disembarking Columbia River Bar Pilots is accomplished by helicopter or boat usually depending on weather conditions. The Bar Pilots also maintain one pilot boat on standby at all times. While awaiting a pilot boarding by helicopter or pilot boat, vessels are advised to stay within a marshalling area approximately 5 miles west of the CR buoy. Pilots boarding by helicopter will generally board within 4-10 miles northwest to southwest of the CR buoy. Boarding by pilot boat generally takes place in the vicinity of the CR buoy.

2.8 COMMERCIAL, SPORT, AND CHARTER FISHING

2.8.1 Sport Fishing

The lower Columbia River supports a diverse fishing industry including sturgeon, salmon, steelhead, bottomfish and crabs and the local offshore fishing includes salmon, halibut, tuna, crab, shrimp, sardine and whiting. The largest fisheries in the River, as measured by boat numbers, are salmon, steelhead and sturgeon which draw tens of thousands of sport anglers each year. These fisheries are very seasonal. The Chinook salmon makes a strong showing both in the spring and the late summer/fall. The spring run of Chinook salmon and steelheads peaks around April. The "Buoy 10 Season", which is focused in the area around Buoy #10, runs from August through early September. The Sturgeon fishing, which runs from May through July, peaks in June. [9] All three fisheries are conducted both with the boats anchored and trolling.

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[8] U.S. Department of Commerce National Oceanic and Atmospheric Administration. United States Coast Pilot Volume 7 (2007). Page 441.

[9] See Appendix O.

The most notable sport fishing season is the “Buoy 10” season, which is the primary salmon season. This fishery, which runs from approximately August 1 through early September, extends from Buoy #10, near the entrance to the Columbia River, upriver past the Astoria-Megler Bridge to Tongue Point. A pamphlet published by the Oregon State Marine Board states that an estimated 5,000 boats are on hand on the weekends in August.[10] The Salmon University Web page states that it is not uncommon to see 300+ boats trolling in an area of 1/2 mile near the buoy.[11]

Photo 2-2 Commercial Fishing Area

2.8.2 Commercial Fishing

The primary commercial fisheries operating on the Columbia River are gill-netters and crabbers. The gill-netters are active from May through October with the busiest period being August – September. Gill nets are used on the Columbia River for salmon, sturgeon, shad, and smelt. Salmon are the primary target of gill-net fishing. Fishing is

[10] “A Guide to Boating in Oregon”, 2006, Oregon State Marine Board

[11] www.salmonuniversity.com/wtc_buoy_10.html

permitted only for short seasons in the spring and fall and in select fish areas in the spring and fall. Select fish areas are areas off the main flow of the Columbia, where fish have been raised and released for the express purpose of having commercial fishermen harvest them. The commercial crabbing is a winter season running from December – February. In addition to the commercial fishing on the Columbia River, a number of fishing vessels operate out of the Columbia River in ocean fisheries. These vessels may also impact or be impacted by loaded LNG vessels transiting the Columbia River. The primary ocean fisheries, based on the number of boats transiting the Columbia River, are crabs and sardines. Halcrow representatives met with some local fishermen on 29 March 2007 to inquire about concerns they might have with the proposed LNG facility. The group was primarily shrimpers that fish offshore. They were homeported in Hammond and were primarily concerned with interferences to their transit in and out of harbor.

2.8.3 Charter Fishing

There are a number of Charter Fishing boats operating out of the marinas located between Astoria and the mouth of the Columbia River. These boats normally depart in the early morning (between 5:00 AM – 6:00 AM) for 8 - hour trips. Table 2-5 lists the names and size of charter fishing companies identified in the area of the transit route.

Table 2-7
Charter Boat Companies, Astoria to the Mouth of the Columbia River

Charter Boat Company	Number of Boats	Location
Beacon Charters	2 - CoHo Sally and Hobo	Ilwaco
Coho Charters, Inc.	4 - Coho King, Coho Leigh High, Coho Mooch, Marr- B III	Ilwaco
Fishin' Time Guide Service	1 boat	Ilwaco
Pacific Salmon Charters	7 boats - Sarah Kay, Star Dust, Katie Marie, Sea Venture, Westward, Sea Angel, Kingfish	Ilwaco
Sea Breeze Charters	Boats – Sea Breeze, Four Seasons, Salty Dog, Nauti-Lady, Sea Crest, Mariner, Ankeny Street, Comanche	Ilwaco
Sea Sport Fishing Charters	Rock-n-Roll, Net Prophet, Big Dipper	Ilwaco
Astoria Yacht Club	Commercial gillnet fleet around salmon net pen docks – approximately 12	Youngs Bay

2.8.4 Fishing Summary

Appendix “O” is a table developed by the Oregon Department of Fish and Wildlife (ODFW) which is a summary of fishing boat numbers in the Columbia River downstream of the Bradwood area. The table was included as an enclosure in Oregon’s Governor Theodore R. Kulongoski’s letter to Secretary Kimberly D. Bose of the Federal Energy Regulatory Commission dated December 13, 2007 regarding the Bradwood Landing Draft Environmental Impact Statement. The table provides an estimated average monthly boat count by fishery in the Columbia River downstream of the Bradwood, OR area. The table includes both the numbers of vessels fishing on the Columbia River and the numbers of vessels transiting the Columbia River to fish offshore. The table highlights the overwhelming significance of the salmon, steelhead and sturgeon fisheries in terms of the number of boats involved. The fishery attracting the largest number of boats is by far the Sport Salmon (Buoy 10) fishery. The four busiest months, by boat count, on the Columbia River downstream of the Bradwood area are April, June, August and September, with August, Buoy 10 Season, being busier than the next two months combined.

These numbers are significant in that the WSA needs to not only address the threats these vessels pose to loaded LNG vessels and the impact such large numbers of boaters has on the Consequence calculations; the WSA also needs to address the impact any recommended safety and security mitigation measures might have on the fishermen during these key fishing seasons. Clearly, there is a heavy concentration of boats on the Columbia River during the months of April, June, August and September. Therefore, any mitigation measures should be tailored so as to minimize their impact during these months. The boat counts for the months of April, June and September are substantially less than the boat counts for August and over time more flexibility may be possible during those three months. However, at the beginning of the operation all four months should be treated as equally congested.

2.9 RECREATIONAL BOATING

Eight marinas were identified and contacted in the area with a total of over 1800 slips as well as nine boat ramps.

(A) MARINAS

- Port of Astoria West Basin
- Young's Bay Yacht Club
- Skipanon Marina
- Warrenton Marina
- Hammond Marina
- Port of Ilwaco
- Ft Canby
- Port of Chinook

(B) BOAT LAUNCHES

The following boat launches are located between the Columbia River entrance and the Astoria-Megler Bridge:

- Ilwaco: Port of Ilwaco 165 Howerton Ave., Ilwaco, WA
- Fort Canby (State Park)
- Port of Chinook, 1 Portland St., Chinook, WA
- Elochoman Marina, P.O. Box 651, Cathlamet, WA
- Hammond: Hammond Marina, 1099 Iredale St., Hammond, OR
- Warrenton Marina, 550 NE Harbor Pl., Warrenton, OR
- Skipanon Marina, 200 NE Skipanon Drive, Warrenton, OR
- Youngs Bay Yacht Club: Youngs Bay Park, Astoria, OR, 503-325-7275
- John Day River, (Tongue Pt., county launch)

(C) MARINE EVENTS

The USCG regulations regarding regattas and marine parades are found in 33 CFR Part 100. 33 CFR Section 100.15 require that, "An individual or organization planning to hold a regatta or marine parade which, by its nature, circumstances or location, will introduce extra or unusual hazards to the safety of life on the navigable waters of the United States, shall submit an application to the Coast Guard District Commander having cognizance of the area where it is intended to hold such regatta or marine parade. Examples of conditions which are deemed to introduce extra or unusual hazards to the safety of life include but are not limited to: An inherently hazardous competition, the customary presence of commercial or pleasure craft in the area, any

obstruction of navigable channel which may reasonably be expected to result, and the expected accumulation of spectator craft."

A review of this subpart showed that the only regattas and marine parades for the Columbia River was the Annual Dragon Boat Races held in Portland, Oregon, (33 CFR 1302), which is 100 miles from the proposed LNG Terminal.

Table 2-8 below, "Coast Guard Permitted Marine Events Astoria/Washington 2005/2006/2007," was provided by LT Scheirman, Coast Guard Sector Portland, OR, and lists all of the marine events that Sector Portland has issued permits for on the Lower Columbia River between the mouth of the Columbia River and Astoria for the years 2005, 2006 & 2007.

Table 2-8
Coast Guard Permitted Marine Events
Astoria/Washington 2005/2006/2007

Marine Events Astoria/Warrenton for year 2005					
MEP#	**Event Name**	**Date**	**Description**	**Size/Number of participants**	**Location of Event**
05-061	Astoria 4th Fireworks	4-Jul-05	Fireworks Display	Unknown	Columbia River at 17th street pier, Astoria
05-066	Astoria Regatta Fireworks	13-Aug-05	Fireworks Display	Unknown	Columbia River at 17th street pier, Astoria
05-106	Astoria Regatta Parade	13-Aug-05	Boat Parade	30	Port of Astoria (buoy 35A) to 17th St. Pier (buoy 39)
Marine Events Astoria/ Warrenton for Year 2006					
MEP#	Event Name	Date	Description	Size/Number of participants	Location of Event
012-06	Astoria-Warrenton July 4th Fireworks	4-Jul-06	Fireworks Display	Unknown	Columbia River at 17th street pier, Astoria
023-06	Astoria Regatta Fireworks	9-Aug-06	Fireworks Display	Unknown	Columbia River in Astoria
071-06	Astoria War Fishing Derby	8-Jul-06	Fishing Derby	50	Columbia River near Hammond, OR
095-06	Astoria Regatta Gillnet Boat Races	12 Aug 06	Regatta	10	Columbia River Astoria at pier 39 to Maritime Museum
085-06	Astoria Regatta Parade	12-Aug-06	Boat Parade	30	Port of Astoria (buoy 35A) to 17th St. Pier (buoy 39)
Marine Events Astoria/ Warrenton for Year 2007					
MEP#	Event Name	Date	Description	Size/Number of participants	Location of Event
07-010	Astoria 4th Fireworks	4-Jul-07	Fireworks Display	Unknown	Columbia River at 17th street pier, Astoria

Halcrow recognizes that not all marine events are officially permitted. Therefore, Halcrow personnel contacted each of the marinas in the area to identify what marine events they had scheduled for 2007. Table 2-7, “Marine Events Sponsored by Local Marinas” is a summary of Halcrow’s findings.

Table 2-9
Marine Events Sponsored by Local Marinas

Marina	Phone	# of Slips	Boat Ramp	Marine Events	Boat #s	Contact
Port of Ilwaco, WA	360-642-3143	800	One in the port; another @ Lewis & Clark National Park	"Tall Ships" /twice	2-10	Cindy Wiegardt & Melissa
				"Loyalty Day: blessing of fleet"	7	
				"Lighted Boat Parade"	10	
	360-642-2291			"Baker Bay Kayak Race"	50-100	Bruce Peterson of The Wade Gallery
Fort Canby, WA	360-642-3078	None	They have a boat ramp @ the Park with two lanes	None		Joe Moses
Port of Chinook, WA	360-777-8797	300	Boat ramp, with two lanes	"Sturgeon fishing tournament" in July	100+	Dan Todd
Hammond Marina, OR	503-861-3197	220	4-lane boat ramp	None		Keith Pinkstaff
Warrenton Marina, OR	503-861-3822	370	2-lane boat ramp	None		Keith Pinkstaff
Skipanon Marina, OR	503-861-0362	109, but 133 total	None	None		Bob Link
Youngs Bay Yacht Club, OR(owned by City of Astoria)	503-325-7275	5-6 day slip for fisher-men	One	None		Tera
Astoria East Basin (owned by Port of Astoria)	503-325-8279 Cell: 503-791-7730	82	One	None		
Astoria West Basin (Owned by Port of Astoria)	503- 325-8279	335 slips	None	None		

2.10 WHALE WATCHING

Gray whales pass by the entrance to the Columbia River twice each year, once on their migration from the Arctic to their wintering and breeding grounds in Southern California and Mexico and on the return trip from the southern climes. The southward migrations begin in December and last until early February, with most animals making their pass in late December and early January.

Although we found one web site which stated that charter boats sometimes took out whale watching tours during the height of the season, we did not find any Charter boat companies advertising whale watching trips.

3. CHARACTERIZATION OF THE LNG FACILITY, THE TANKERS AND THE TANKER ROUTE

3.1 THE PROPOSED LNG FACILITY

Oregon LNG is proposing to develop an LNG import facility at Warrenton, Oregon. The Oregon LNG CEO is Peter Hansen. Mr. Hansen's office is located at 8100 NE Parkway Drive, Suite 165 Vancouver, WA 98662, (503) 298-4966.

The LNG Terminal will include a marine terminal consisting of a pier with one LNG berth, LNG unloading equipment consisting of fully-articulated unloading arms and cryogenic transfer piping, an LNG storage facility consisting of three full-containment LNG storage tanks, vaporization and vapor handling systems, a send-out system, and administrative, control and support buildings

The proposed Project Site location is shown on Figure 3-1.

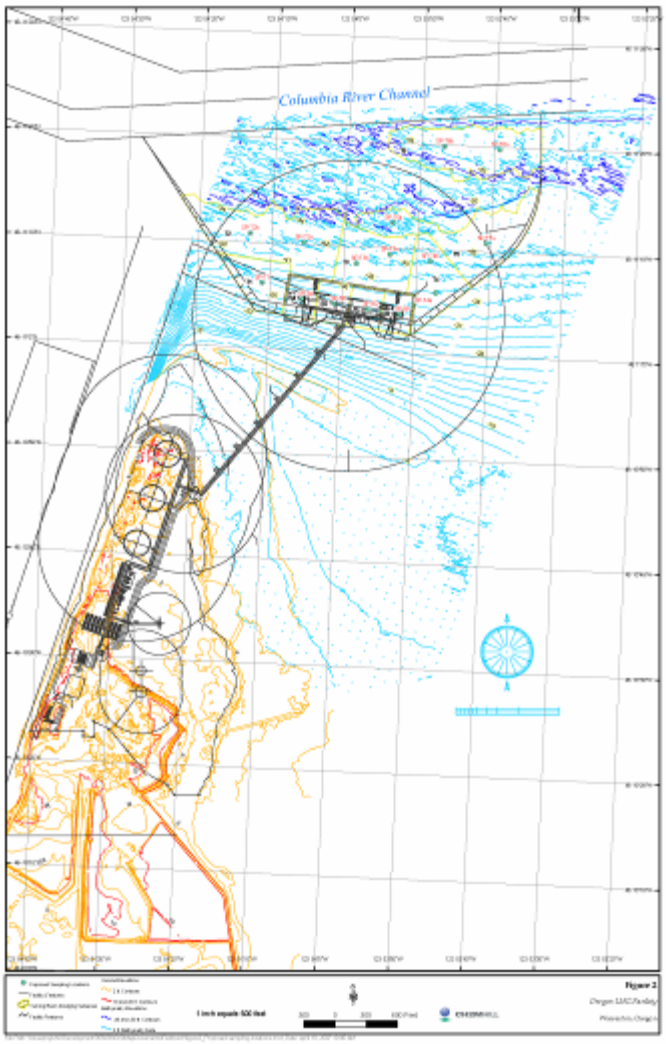

Figure 3-1: Proposed Oregon LNG Terminal Site

3.1.1 Marine Terminal

The proposed Project will include the construction and operation of a single berth marine terminal designed to berth and unload LNG tankers of up to the Q-Max class (approximately 263,000 to 266,000 cubic meters (m^3)). Approximately two to three ships per week will call at the Terminal. If the larger LNG ships (Q-Max) are employed the number of ship calls may drop to only 1 – 2 per week.

Once berthed, LNG ships will transfer LNG using the ship's pumps through stainless steel unloading arms that are connected to a common stainless steel unloading header. The unloading header will transfer the LNG to the LNG storage

tanks. Vapor that is displaced from the storage tanks when the LNG is introduced into them will be transferred back to the ship through a vapor return pipeline to minimize pressure increase in the storage tanks and to maintain a constant pressure within the ship's cargo tanks during unloading.

Oregon LNG will design the marine terminal in accordance with applicable codes and standards, including the following: Oil Companies International Marine Forum ("OCIMF"); Society of International Gas Tanker and Terminal Operators ("SIGTTO"); American Petroleum Institute ("API"); and American Society of Civil Engineers ("ASCE"). The Project will be designed to provide a safe berth for the receipt and support of LNG ships and to ensure the safe transfer of LNG cargoes from the ships to the onshore storage tanks.

3.1.2 Onshore Facility

LNG Terminal Pier/Trestle:

The facility's calculated mooring rating for an LNG vessel with a 266,000 cubic meter capacity is sustained wind speed of up to 56 knots (64 MPH). Sustained wind speed denotes duration of 10 minutes with an average velocity of 56 knots measured at the terminal. Figure 3 in Appendix U shows that the mooring system can handle winds of up to 70 knots over a 30 second period which converts to winds of 56 knots with a 10 minute period. The capacities were calculated using the OPTIMOOR program based on preliminary design criteria for two different size LNG vessels. More specific calculations should be run during final design for each vessel based on each vessel's actual "As Built" drawings. Note the calculated mooring rating of 56 knots (10 minute period) is greater than the 100 year return period wind speed of 50 knots (58 mph). The 100 year return period includes 3 second gusts of up to 81 MPH. [12]

(A) LNG STORAGE TANKS

LNG unloaded from the ships will be transferred to and stored in above-ground 160,000 cubic meters (m^3) net full-containment storage tanks. The tanks have been designed and will be constructed so that the self-supporting primary container and the

[12] Oregon LNG Terminal and Pipeline Project Wind/Current Data Analysis Alignment Alternatives Study". Table 4, Page 6.

secondary container will be capable of independently containing the LNG. The primary container will contain the LNG under normal operating conditions. The secondary container will be capable of containing the LNG (110 percent capacity of the inner tank) and controlling the vapor resulting from the unlikely occurrences of product leakage from the inner container. Each insulated tank is designed to store a net volume of 160,000 cubic meters (1,006,000) of LNG at a temperature of -260F and a maximum internal pressure of 4.3 pounds per square inch gauge (psig).

Transfer piping will enter into and exit from well-sealed passages in the top of the tanks. There will be no penetrations through the inner or outer walls or through the bottom of the tank. Low-pressure send-out pumps in each tank will supply low-pressure LNG to the higher pressure 'send-out' pumps. An earthen barrier will be installed around the storage tanks and process equipment.

(B) VAPORIZATION SYSTEM

LNG from the storage tanks will be transferred by low-pressure in-tank pumps to the high-pressure send-out pumps. Once LNG leaves the discharge of the high-pressure pumps, it will enter a vaporization system where the LNG is warmed and turned from its liquid form into its gaseous form. It is currently anticipated that the vaporization system will consist of ambient air vaporizers supplemented by boilers.

The Project will be designed with a natural gas send-out capacity of 1.0 billion cubic feet per day ("Bcf/d") for routine operations and a peak capacity of up to 1.5 Bcf/d if there is a demand.

(C) VAPOR HANDLING SYSTEM

During normal operation, ambient heat input into the LNG storage tanks will cause a small amount of LNG to vaporize, commonly referred to as boil-off gas. Some boil-off of LNG will also be caused by other factors, such as barometric pressure changes, heat input from the LNG pumps, and ship vapor flashing. The boil-off from the LNG storage tanks will be compressed by the boil-off gas compressors and then passed through a condenser system where it will be combined with the outgoing LNG before being pumped up to pipeline pressure by the second stage high-pressure pumps.

During ship offloading, a portion of this vapor will be returned to the ship to compensate for volume of liquid pumped out of the tank into the onshore LNG storage tanks. The vapor handling system will be a closed system designed to prevent the venting of vapor into the atmosphere. Pressure relief will be provided to ensure overpressure protection to the LNG storage tanks.

(D) SITE UTILITIES

Electricity for operation of the LNG Terminal will be supplied from the local utility, although on-site generation will be considered during the preparation of the front end engineering design. Appropriate design and feed systems will allow for redundancy and back-up of equipment at the Terminal. Additionally, an emergency generator will be included in the terminal design to ensure critical system components can continue to run and ensure safe operation of the LNG Terminal should a power outage occur.

The source of potable water and water required for fire protection will be determined during the preparation of the front end engineering design. Consideration will be given to supplies from off-site public utilities.

The fire protection system will be constructed in accordance with National Fire Protection Association ("NFPA") requirements, and the firewater system will provide adequate storage and coverage for the entire Terminal. The firewater system will include an emergency back-up system should the primary supply of firewater be interrupted, such as in the case of a power outage.

Considerations for the treatment and disposal of sewage and waste water from the LNG Terminal will be made as the front end engineering design for the Terminal is prepared. Considerations will be given to discharges into the local sewer system. An oily-water storage system will be installed to collect and treat any oil-contaminated drains.

(E) ADMINISTRATIVE BUILDING, CONTROL ROOMS, AND OTHER SUPPORT BUILDINGS

The LNG Terminal will include a permanently manned onshore control room as well as a control room at the pier unloading platform that will be manned during LNG unloading operations. Other buildings that will be installed at the Terminal include an administrative building that will contain offices and training facilities, a maintenance

building and warehouse, a security building, utility buildings and a boil-off gas compressor building.

3.2 THE PROPOSED TANKERS

LNG tankers vary in size, capacity, and design of containment systems as outlined in this section, but all of these ships have double hull construction and rely on insulation to keep the LNG liquid cargo at -260 degrees Fahrenheit (^{o}F). The cargo is carried at atmospheric pressure in specially insulated tanks referred to as the cargo containment system inside the inner hull.

There are two primary LNG ship containment systems; independent tanks and membrane tanks. Independent tanks are completely self supporting and do not form a part of the ship's hull. The independent tanks for the carriage of LNG come in two types; Type "A" and Type 'B' tanks. Type 'C' tanks are for pressurized gases; therefore, they are not used in the LNG trade. Whereas the independent tanks are independent of the hull of the ship, the membrane type tanks conform to the shape of the ship's hull and use the ship's structure as the strength member to contain the cargo. A membrane tank allows more cargo to be carried on the vessel as there is no wasted hold space between the cargo tank primary barrier and the secondary barrier. There are three types of membrane containment systems, Gaz Transport, Technigaz and the Ishikawajima-Harima Heavy Industries Company (IHI) self supporting system. Oregon LNG expects to service both Independent and membrane-type LNG ships.

Figures 3-2 and 3-3 are cutaways of a typical LNG vessel with a membrane containment system. Figure 3-4 is a cross section of an independent (Moss) containment system.

Figure 3-2: Membrane LNG Vessel Cut Away

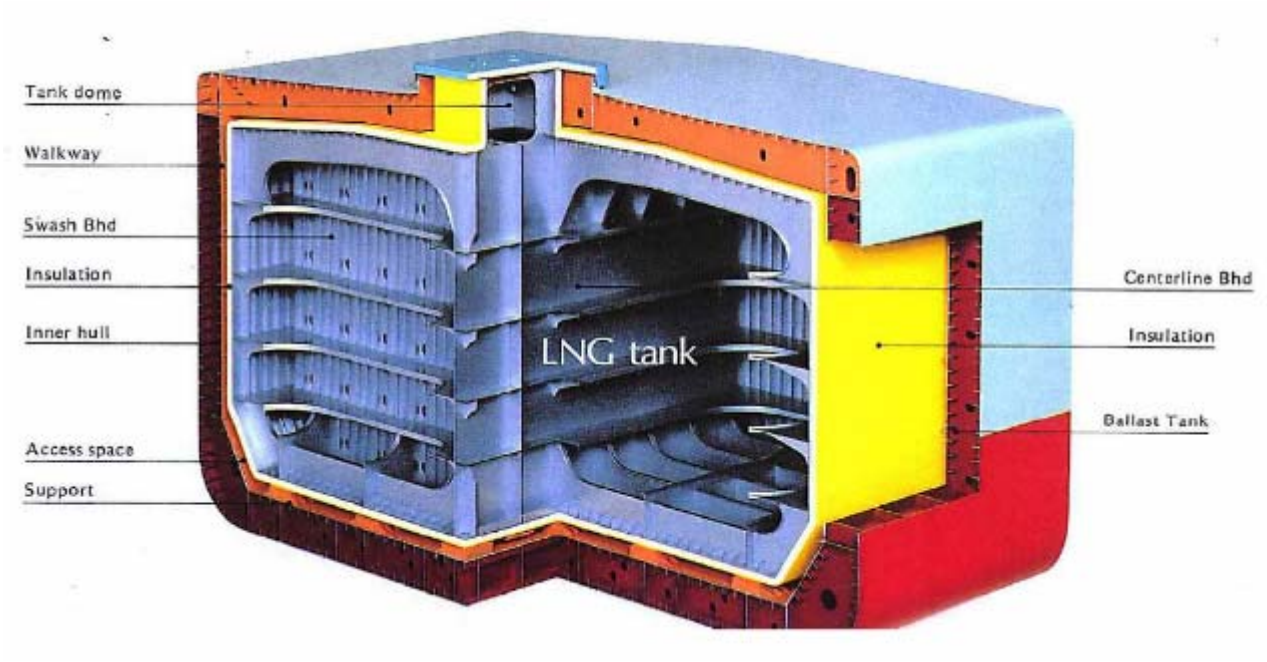

Figure 3-3: Cross-Section of a Membrane LNG Ship's Hull & Containment System

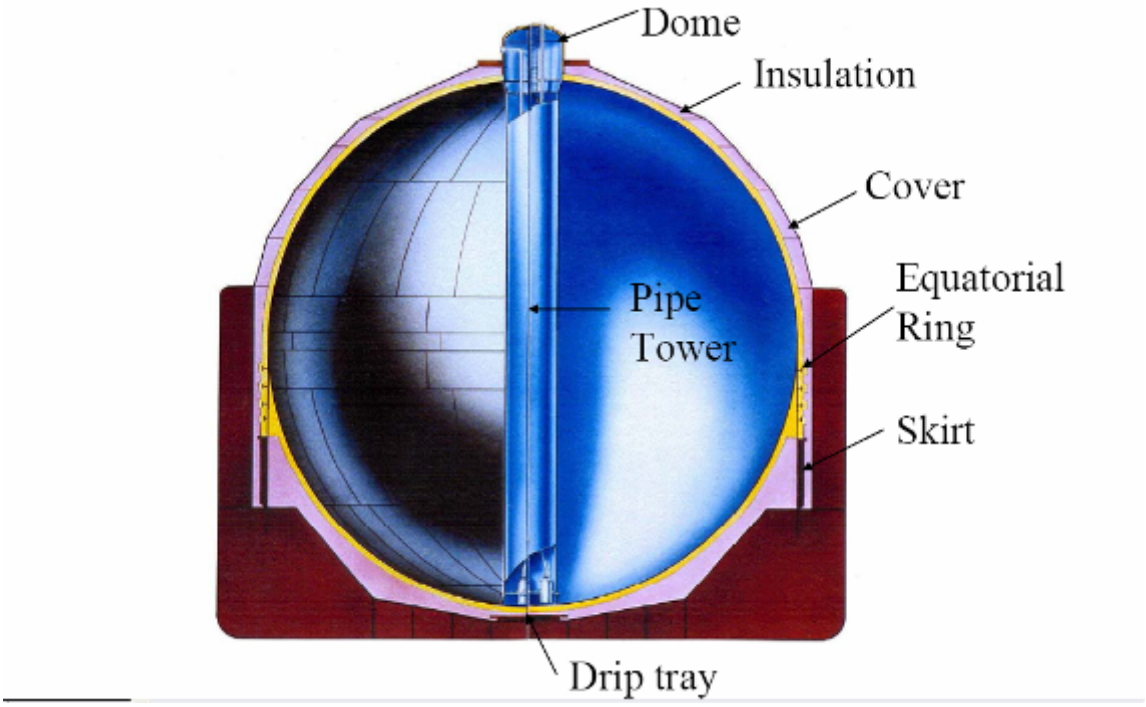

Figure 3-4: Cross-Section of an Independent LNG Ship's Hull & Containment System

Oregon LNG is currently evaluating a number of possible tankers of up to and including the Q-MAX class (263,000 - 266,000 m^3). Many of the larger LNG carriers are still being designed and built. Specifications vary as to specific builders and tank types. However, general size parameters are similar to the class of vessel. Table 3-1 provides specifications of the larger types of vessels being evaluated.

Table 3-1
Tankers under Consideration for Oregon LNG Terminal

Specification	Conventional 145,000m^3 Capacity	Q-FLEX 217,000m^3 Capacity	Q-MAX 263,000 – 266,000 m^3 Capacity
Length Overall	928 ft (283 m)	1033 ft (315m)	1,132 ft (345 m)
Beam	142 ft (43.4 m)	164 ft (50m)	180 ft (55 m)
Draft – Loaded	39 ft (12 m)	39.4 ft (12m)	40 ft (12.2 m)
Draft – In Ballast	31 ft (9.6m)	33 ft (10m)	33 ft (10m)
Air Draft - Loaded	125 ft (38 m)	167 ft (51m)	165 ft (50.4m)
Air Draft – In Ballast	133 ft (40.4m)	174 ft (53m)	174 ft (53m)

3.3 THE PROPOSED TANKER ROUTE

The proposed transit route extends approximately 21.65 miles from entry into U.S. Territorial Waters (12 mile limit), through the mouth of the Columbia River, along the Lower and Upper Desdemona Shoal Channels, and to the proposed Project Site at Warrenton, Oregon. Table 3-2 provides a detailed description of the route track legs, the available channel widths, nearest distance to land, and whether there are any restricted/danger zones. Charts are attached in Appendix A with the Zones of Concern described in NVIC 05-05 superimposed to provide a visual representation of the track line and potential impact of a cargo tank breach.

Table 3-2
Tanker Route from High Seas through Columbia River Entrance to Proposed Oregon LNG Terminal Site

Track Leg #	Track Leg Name or Description	Transit Leg Way Points (Latitude/Longitude)	Bearing (Degrees True)		Distance (nm)		Channel width & depth (ft) *		Nearest distance to land (yds)	Danger or Restrict Zones
			In	Out	Leg	Total	Width	Depth		
1	High Seas to CR Entrance Range	46-10-24N 124-20-30W // 46-11-45N 124-10-03W	080	260	7.2	7.2	Open Ocean	160+	7400	None
2	CR Entrance Range Chan'l	46-11-45N 124-10-03W // 46-15-17N 124-04-57W	045	225	5.0	12.2	2640	80-46	1200**	None
3	Sand Island Range Chan'l	46-15-17N 124-04-57W // 46-15-27N 124-02-48W	080	260	1.6	13.8	2640	80-46	900**	None
4	Turn leg passing Buoys 11 & 12	46-15-27N 124-02-48W // 46-15-26N 124-01-40W	097	277	0.75	14.55	1600	125-68***	750**	None
5	Turn leg to Buoy 14	46-15-26N 124-01-40W // 46-15-12N 124-00-58W	117	297	0.55	15.1	1000	91-68***	1350**	None
6	Lower/Upper Desdemona Shoal Channel	46-15-12N 124-00-58W // 46-11-29N 123-55-01W	132	312	5.6	20.7	600	76-44	400	None
7	Tansy Pt. Turn to Turning Basin	46-11-29N 123-55-01W // 46-11-18N 123-53-59W	105	285	0.75	21.45	1050	47-44	550	None
8	Turning basin to dock	46-11-18N 123-53-59W // 46-11-04N 123-53-59W	180	000	0.2	21.65	1800+	45-50****	550	None

* Depths indicated for dredged channels are based on the 2007 Corps of Engineers dredge surveys. Control depths range from 55ft to 44ft in entrance (from north to south in quadrants) and 43 ft in Desdemona Shoals Channel and further up river. The actual depths are deeper than control depth in most cases. Dredging practice authorizes dredging up to 5 ft deeper than control in order to minimize maintenance dredging.

** Distances taken for track legs 2, 3, & 4 measured to tips of jetties. Track leg 2 to tip of south jetty and north jetty approximately the same at 1200yds. Nearest point to actual land would be 1700yds at base of north jetty at Peacock Spit. Distance to land for Track leg 3 measured to Jetty A. Nearest point to actual land mass is 1600yds to base of North Jetty at Peacock Spit. Track leg 4 was measured to Jetty A. Distance of track leg 4 is 1600 yds to lower tip of Sand Island. Track leg 5 is 1450 yds from southern tip of Sand Island.

***Track legs 4 and 5 transit through a transition area where the wider, deeper river entrance turns and narrows into the river channel. It is naturally deep water with the northeast side of the charted channel area much deeper than the southwest side.

**** Indicates planned depths for dredging the turning basin and area around ship. Turning basin planned for 45ft depth. Area adjacent to terminal pier face and out approximately 200 ft planned for a depth of 50 ft to provide more water under the keel where ship is moored.

The ship transit for the purpose of this report begins on the high seas, entering the U.S. territorial sea limit 12 nautical miles west of the Oregon coast line. LNG Ships will generally steer for a position about 5 – 10 nautical miles west of the Columbia River Approach Lighted Whistle Buoy CR (CR Buoy) to await embarkation of the Columbia River Bar Pilots and/or Coast Guard boarding teams before proceeding into the Columbia River. The entry point into US waters depicted and the offshore track line to the position west of the CR Buoy is a "generic" representation of a LNG ship route. Slight variations may occur depending on the originating source of the LNG cargo. Potential source countries vary geographically ranging as far south as Australia and as far north as Russia, which in turn may result in ships transiting to the United States along the northern or southern great circle routes of the Pacific Ocean. Regardless of the great circle route taken, the ships normally transit well offshore, from 25 nautical miles off to 50 nautical miles off until they head in towards the port of destination. In this case, ships will proceed to the position 5 – 10 nautical miles west of the CR Buoy mentioned previously and after embarking a pilot will head in towards the mouth of the Columbia River close to the representative track line described in this report.

The inbound track line from sea continues past the CR buoy approximately one nautical mile where it intersects track leg 2 that proceeds along the Columbia River Entrance Range Channel. Ships transit along this track leg steering on the Columbia River Entrance Range, a terrestrial navigational range located on Cape Disappointment, marking the center of the channel. This leg is approximately 5 nautical miles long and enters the general area referred to as the "Columbia River Bar." There are rock jetties on both sides of the river entrance. Approximately 0.6 nautical miles from the end of this inbound track leg, the ship would cross "River Mile 0" (RM 0), which is marked on the nautical chart where the track line is intersected by a line connecting the seaward ends of the North and South jetties. RM 0 begins the measuring system commonly used in the Columbia River based on statute miles. At the end of track leg 2, ships will cross the Collision at Sea Regulations (COLREGs) line of demarcation, shifting them from international rules of the road to inland rules of the road. The COLREGs line extends from the exposed tips of the north and south jetties.

The Entrance Range Channel is 2640 feet wide. The Army Corps of Engineers (ACOE) does maintenance dredging in the channel to maintain the control depths usually out to RM -2 before the water is naturally deep enough not to require

maintenance dredging. Maintenance dredging is required into the river generally to RM 2 where again the water becomes naturally deep enough so that dredging to maintain control depths is unnecessary. In this entrance area, which encompasses the Columbia River Bar area, the northern 2000 feet is maintained to a controlling depth of 55 feet (below MLLW) and the southern 640 feet of the channel is dredged to 48 feet.

As mentioned, the Columbia River mouth has jetties on the north and south sides. The south jetty projects seaward from Clatsop Spit approximately 2.8 nautical miles with the last mile submerged. The end of the submerged jetty is marked by South Jetty Bell Buoy "2SJ". The track line passes approximately 1200 yards to the north of the charted submerged part of the southern jetty. There are no known obstructions within the channel. Two obstructions were noted on the nautical chart (NOAA 18521) north of the channel within the Army Corps of Engineer (ACOE) shallow water dumping area. Examination of the 2007 hydrographic surveys of the area revealed that there were no unusual obstructions at a depth that would be a grounding threat to a LNG ship. The channel itself is well marked with the terrestrial range and lighted buoys. Lighted Buoys 1, 3, 7, and 9 mark the north side of the Entrance Channel and Lighted Buoys 2, 4, 6, and 8 mark the south. At the turn point from track leg 2 to track leg 3, the track line is at its closest point of approach to the seaward tip of the North Jetty, which is 1200 yards to the north. The North Jetty extends approximately 900 yards seaward from Peacock Spit.

From the Entrance Range Channel, the inbound track line turns right onto track leg 3, through the center of the Sand Island Range Channel. This track leg is about 1.75 nautical miles in length and steers on the Sand Island terrestrial range. The channel is 2640 feet wide as was the case for the Entrance Channel, but begins narrowing slightly at the end of the track leg as the channel approaches Jetty A and begins a turn south to meet the Desdemona Channel. Lighted Buoy 11 marks the northern edge and Lighted Buoy 10 marks the southern edge of the channel. The track line turns south (right) off of the terrestrial range prior to reaching Lighted Buoy 11 and about 600 yards south-southwest of Jetty A that extends south from Cape Disappointment.

Track legs 4 and 5 are relatively short turn legs to transition from the wider Sand Island Range Channel and the challenges of the Columbia River Bar into the Lower Desdemona Shoal Channel, which is a much narrower channel and more traditional

river transiting conditions. Track leg 4 turns south for about 0.7 nautical miles and track leg 5 goes for another 0.8 nautical miles. As the channel turns south it narrows from the width of the Sand Island Range Channel to the 600 foot wide Lower Desdemona Shoal Channel. This segment of the river experiences very strong currents and is naturally deep water. As can be seen on the hydrographic surveys, depths are commonly over 70 feet in the center part of the channel in this area of the track. Lighted Buoys 12 and 14 designate the edge of good water on the south side. South and west of Buoy 14 is shoal water that extends north from the tip of Clatsop Spit. The water to the north and east of the track line is deep well outside the charted channel. There is a "Channel Leading Light" on Jetty A to the north of the track line that provides a steering aid for transiting the Lower and Upper Desdemona Shoal Channels. Track leg 5 ends just prior to reaching Lighted Buoy 14.

Track leg 6 extends 5.3 nautical miles along the east side of Clatsop Spit in the center of both the Lower Desdemona Shoal Channel and Upper Desdemona Shoal Channel While the Desdemona Shoal Channel name changes (Lower and Upper) between Lighted Buoys 21 and 22, it is a continuous, straight channel that extends from the tip of Clatsop Spit to the Tansy Point turn. Lighted buoy 14 on the right side of the channel when inbound marks the nearest shoal water of the track leg. The shoal water projecting north from the tip of Clatsop Spit comes within approximately 200 yards of the track line between Lighted Buoys 14 and 20. The right side of the channel is marked by Lighted Buoys 14, 20, and 22. The left side of the channel when inbound, is marked by Lighted Buoys 21, 25, and 27.

The U.S. Army Corps of Engineers (USACE) Channel Improvement Project is a dredging project that is deepening the entire main ship channel from the river mouth to Portland, Oregon, from the present 40 foot controlling depth to 43 feet. While the project is not expected to be complete until 2008, dredging for the section of river encompassing the track line to the proposed site is complete. The additional depth is attributed to either naturally deep water in the river or the practice of dredging over the authorized depth by up to 5 feet for what is known as "advanced maintenance dredging." The intent of this advance maintenance dredging is to account for silting and prolong the time period between required dredging to maintain the control depth. That practice of dredging an additional 5 feet also applies to the entrance channel so that the depths in the river mouth are generally more than the required 55-48 feet.

While the entire Desdemona Shoal Channel is well within the channel control depth requirements, the depth varies somewhat due to naturally occurring river silting/shoaling. The depth of the Desdemona Shoal Channel varies such that on an inbound course the Lower Desdemona generally has deeper water on the left side (east) due to the Clatsop Spit shoaling on the right. The Upper Desdemona has deeper water to the west side due to encroachment of the channel by the Desdemona Sands shoal on the east side Accordingly, a change is being considered to relocate the Desdemona Shoal Channel slightly on the NOAA nautical charts to follow the naturally deeper water more closely. Since that change is only under consideration and not approved, this report will use the existing channels on the NOAA nautical charts.

Lower Desdemona Shoal Channel passes the northern part of Clatsop Spit which is part of Fort Stevens State Park. The northern part of Clatsop Spit does not have any permanent residences/population but is frequented by people that are hiking, beach combing, visiting the USACE observation site for the Columbia River jetties, or other outdoor pastimes. More people frequent that area in the summer when the park has numerous vacationers/campers.

Upper Desdemona Channel passes the town of Warrenton, Hammond Marina, and Tansy Point, which has the Warrenton Fiber docks where tug and tows moor to transfer wood products. Ships transiting the Upper Desdemona track leg will pass over a submerged communications cable area that extends under the River from Warrenton, Oregon toward Chinook Point on the Washington side.

The track line then turns left, or to the south east, at the Tansy Point Turn onto track leg 7 which heads across the Tansy Point Range Channel towards the anticipated location of the turning basin just south of the ship channel. Once in the turning basin, the LNG ship will be assisted to the pier by the tugs. As discussed in the "Oregon LNG Simulation Report" (Appendix T) the Pilots felt that, "… they should have the option of docking port or starboard side, depending on the conditions." [13]

3.3.1 Tides and Currents

As indicated in Tables 3-3 and 3-4 below, the Columbia River experiences a tidal range that averages over 6 feet within the river entrance in the areas of the track line

during normal tide conditions and averages well over 8 feet on the extreme, diurnal tides. While the mean tide level is over +4 feet, providing a comfortable buffer over the Mean Lower Low Water (MLLW) depths indicated on the "charted depths," it is not infrequent on ebb tides to have a minus tide level.

The current practice of the Bar Pilots is to bring deep draft ships into the Columbia River for the transit up river only when they have at least 4 feet of water under the keel on a falling tide and 3 feet under the keel on a rising tide.[14] If the tide level is too low, ships offshore awaiting entry into the river may be delayed until the tide rises enough to permit entry. If this rule of thumb is also applied to LNG ships transiting to/from the proposed Oregon LNG Terminal using the control depth of 43 feet as the criteria, there may be a small number of times during the year that delays in entry may be necessary. If the channel depth basis is the actual ACOE survey depths it is likely that there is sufficient water to enter port without delay even on extreme low tides for the smaller LNG ships and very few delays for the largest ships.

Along the track route, at the Warrenton location, 29 days were predicted with minus tides -1.5 feet or more for 2007[15] and one day for a minus tide of -2 feet. With a control depth of 43 feet, these minus tides would reduce the depth in the channel to 41.5 and 41 feet respectively. Considering that the LNG ship types listed in Table 3-1 had "loaded" drafts of 39 feet for the 145,000 cubic meter size ship and 40 feet for the largest 265,000 cubic meter ship, the extreme minus tides create a potential restriction to the navigability for LNG ships entering the Columbia River bound for the proposed site. For the short period before and the low tide, the tide would be falling and the pilots may decide to wait until the low tide is reached and/or the flood begins. If the actual survey depths are used to determine depth under keel, the Desdemona Channel has several feet more in depth and the transit may not need to be delayed if necessary to better facilitate ship schedules. LNG ships departing from the proposed site in ballast with between 31 and 33 foot drafts would not be restricted based on tide levels.

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[13] "Oregon LNG Simulation Report" dated 01/03/2008. Page 6.

[14] Discussion/email with Captain Gary Lewin of Columbia River Bar Pilots on 4/9/2007

[15] NOAA Tide Tables 2007 West Coast of North and South America

It is expected that the turning basin will be dredged to 45 feet with some additional depth for advance maintenance dredging. As illustrated in Table 3-5, the Warrenton location, which is near the proposed terminal location, is predicted to have 52 days in 2007 with a minus tide level that is -1 foot or more and 12 days that the minus tide exceed -1.5 feet. There were no minus tides predicted that exceeded 2 feet. There should always be water under the keel in the turning basin and at the dock, which is projected to be dredged to 50 feet. Since the turning basin will have a deeper control depth than the ship channel, maneuvering the ship should not impact decision making for piloting the ships in and out of the Columbia River.

Table 3-3
Tidal Ranges – Columbia River Entrance to Astoria

Location*	Mean Range (feet)*	Diurnal Range (feet)*	Mean Tide Level (feet)*	Correction Factor**		Highest 2007 Diurnal Tide *** (10/27/2007)	Lowest 2007 Diurnal Tide *** (06/15/2007)
				High Water	Low Water		
Columbia River entrance (N. Jetty)	5.6	7.5	4.0	-1.0	+0.1	9.3	-1.8
Ft Canby, Jetty 'A'	6.31	8.48	4.58	^0.97	^1.22	10.0	-2.3
Hammond, Ore	6.38	8.32	4.45	^0.96	^1.08	9.9	-2.1
Warrenton, Skipanon River	6.5	8.3	4.4	-0.1	+0.1	10.2	-1.8
Astoria (Youngs Bay), Ore	6.7	8.6	4.5	+0.1	+0.1	10.4	-1.8
Astoria (Port Docks), Ore	6.2	8.0	4.2	-0.5	0.0	9.8	-1.9

* Location of tide stations and associated values for mean range, diurnal range, and mean tide level extracted from Table 2 of "Tide Tables 2007 West Coast of North and South America" publication. All tide levels based on MLLW. All depths are in feet.

** Correction factors (Differences) used to obtain highest and lowest diurnal tide values are taken from Table 2 of "Tide Tables 2007 West Coast of North and South America" publication. "^" indicates a ratio that requires multiplying the reference station values. Astoria (Tongue Pt), Oregon is the reference station listed in Table 1 for Daily Tide Predictions on pages 112 to 115.

*** Values for maximum diurnal tides were extracted from Astoria (Tongue Pt), Oregon reference station of "Tide Tables 2007 West Coast of North and South America" publication: highest tide determined for 2007 on 10/27/2007 at +10.3 ft, and; lowest tide determined for 2007 on 06/15/2007 at -1.9 ft. Tide levels based on MLLW.

Table 3-4
Currents – Columbia River Entrance to Astoria

Location*	Average Speed (kts)*		Direction (Deg T)*		Speed Ratios*		Maximum Speed (kts)**	
	Max Fld	Max Ebb	Flood	Ebb	Flood	Ebb	Max Fld	Max Ebb
Columbia River Approach Lighted Whistle Buoy	***	***	***	***	***	***	***	***
Columbia River Entrance (River Mile 0)	****	****	*****	*****	****	****	4+****	8****
Sand Island Tower, 1nm SE of (mid channel)	3.0	4.4	107	275	1.6	1.6	5.0	7.5
Clatsop Spit, NNE of	2.6	3.2	114	289	1.4	1.1	4.3	5.2
Clatsop Spit, NE of	0.8	2.8	131	313	0.4	1.0	1.2	4.7
Hammond, NE of ship chnl	0.8	1.7	134	307	0.4	0.6	1.2	2.8
Youngs Bay Entrance	1.7	1.1	093	260	0.9	0.5	2.8	2.4
Astoria Range	1.2	2.8	088	243	0.6	1.0	1.9	4.7

* Location of current stations and associated values for Average Current Speed, speed ratios, and direction were extracted from Table 2 of "Tidal Current Tables 2007 Pacific Coast of North America and Asia" publication.

** "Maximum" flood/ebb current speeds derived from speed ratios obtained in Table 2 for each monitoring station and applied to (multiplied) the maximum ebb/flood speeds predicted for reference station of Grays Harbor Entrance in 2007 on pages 36-39. Maximum currents predicted for Grays Harbor were 3.1kts flood and 4.7kts ebb.

*** Excerpt from page 226 of "Tidal Current Tables 2007 Pacific Coast of North America and Asia" - "The tidal current here is rotary, turning counter clockwise, but rather weak. The speed of the current at strength being about 0.3 knots setting 020 degrees on the flood and 200 degrees on the ebb.

The current from the Columbia River completely masks the flood current; observations showing that there is a nontidal current at the buoy location with an average speed of 0.4 knots setting 235 degrees from February to October and 295 degrees from October to February. When there is considerable runoff from the river, the combined tidal and nontidal current at the buoy frequently attains a speed of 2 knots or more in a southwesterly direction. The greatest observed speed here is 3.5 knots."

**** Note <15> on page 214 of the "Tidal Current Tables 2007 Pacific Coast of North America and Asia" states, "It is reported that ebb currents on the north side of the bar attain speeds of 6 to 8 knots and that strong NW winds sometimes cause currents that set north in the area outside the jetties. In the entrance, the currents are variable and may reach a speed of more than 5 knots on the ebb while the flood speed seldom exceeds 4 knots."

***** In addition to the specific comment about strong NW winds causing northerly currents outside the jetties, the following description of currents in the Columbia River entrance is provided on page 441 of "Coast Pilot 7": "on the flood there is a dangerous set toward Clatsop Pit, its direction being approximately ESE; on the ebb the current sets along the line of buoys."

Table 3-5
Extreme Tide/Current Daily Frequency

Month 2007	Minus Tide Levels (ft)*					Currents (kts)*		
	Warrenton		Hammond			Ebb		Flood
	≥ -1.0	≥ -1.5	≥ -1.0	≥ -1.5	≥ - 2.0	≥ 4.0	≥ 5.0	≥ 4.0
January	1	0	6	0	0	13	0	3
February	0	0	0	0	0	10	0	4
March	0	0	0	0	0	7	0	4
April	3	0	3	0	0	6	1	3
May	5	3	6	4	0	7	1	2
June	7	3	13	5	1	11	0	0
July	13	3	15	9	0	13	0	0
August	7	0	12	2	0	10	0	3
September	2	0	3	0	0	6	0	2
October	5	1	5	3	0	8	2	3
November	5	2	6	4	0	9	2	3
December	4	0	6	2	0	11	2	3
Totals	**52**	**12**	**75**	**29**	**1**	**111**	**8**	**30**

*Data derived from 2007 NOAA Tide Table and 2007 Tidal Current Table

The tides combined with the strong outgoing Columbia River current result in very strong and varied tidal currents that create challenging conditions for ship navigation and maneuvering on and off of the dock. Table 3-4 clearly displays the average and more extreme current velocities at various locations near the transit area. The combination of the outgoing river current and an ebbing tide normally results in a much stronger ebb current than the floods. It is not unusual for ebb currents to exceed 4 knots and occasionally 5 knots at the NNE of Clatsop Spit measuring station, which provides a good reading for currents experienced as ship enter the Lower Desdemona Shoal Channel moving from the river mouth area and into the river "proper" transit. A review of tidal current predictions for the year 2007[16] revealed that ebb currents exceeded 4 knots 111 days and of those, 8 days exceeded 5 knots. While the currents are not as strong as the ebbs, they are still very significant and potentially create more of a navigational challenge to incoming ships trying to maintain steerageway. Tidal

[16] Tidal Current Tables 2007, Pacific Coast of North America and Asia

current predictions for 2007[17] indicate that 30 days of the year may experience flood currents great than 4 knots at the NNE Clatsop Spit measuring station.

There is little actual data for calculating current velocities further out in the mouth of the Columbia River, such as in the Entrance Range Channel. That area is in the Columbia River Bar area which receives a great deal of heavy weather. Attempts by NOAA to place measuring devices there resulted in lost equipment. As stated in the Table 3-4 and the notes, speeds of 6-8 knots have been reported for ebb currents in the northern area of the river mouth. Based on the ebb current speeds indicated at the Sand Island tower station with an extreme ebb current speed of 7.5 knots, the "reported" current speeds in the Columbia River Bar are feasible.

As apparent from the above discussion on the tides and currents within the Columbia River, local knowledge and experience is essential for the safe navigation of large ships entering and departing the Columbia River. These conditions are precisely the reason for compulsory pilotage in the Columbia River for deep draft vessels, such as the LNG carriers. The Columbia River Bar Pilots and Columbia River Pilots constantly monitor the state of river conditions in terms of tides, currents, shoaling, and "Bar" conditions. They adjust navigation practices to account for the real time local conditions. It should be noted that while the track line is drawn on the chart in the center of the channels, it is understood and expected that the Pilots may adjust ship tracks within the channels as appropriate to account for currents or water depth variance due to silting/shoaling or simply to follow the deeper water in channels in lower tide situations.

3.3.2 Weather

CH2M HILL conducted a study entitled "Oregon LNG Terminal and Pipeline Project Wind/Current Data Analysis Alignment Alternative Study" which is included as Appendix "P" of this WSA Report. One of the purposes of this study was to:

- "Collate collected wind data, correlate with long term data available at the adjacent Astoria Airport, and perform extremal analysis to extract design wind speed and direction.

[17] Tidal Current Tables 2007, Pacific Coast of North America and Asia

As part of this Study, wind speed and direction data was collected near the project site at Green Channel Marker No. 3 on the east bank of the Skipanon River Channel for a one year period from February 2005 through January 2006. This data was then compared to data taken over a 30-year period at the nearby Astoria-Airport which was obtained from the Oregon State Climatologist's Office and used for verification of and correlation with the site data. As expected, a very high correlation was found between the two data sets, in excess of 90%. It has therefore been determined that the transformed Astoria Airport data is sufficient for use for the LNG marine facility design."[18]

The Skipanon River and Astoria Airport data indicate the strongest winds at the dock can be expected in the Fall and Winter months beginning in October and lessening by April. They tend to follow a seasonal direction pattern. Fall and winter months predominantly experience winds from the east and south, varying from the east-northeast (ENE) to the south-southwest. (SSW). The strongest winds come from the south or southwest. By April the spring season brings a lessening of the wind speeds and a shift in the predominant wind pattern coming more from the west, varying from the southwest to northwest. In the summer months, the stronger winds come from the northwest although they do not normally achieve the same wind speeds as seen in the winter storms.

Finally, the Windographer Wind Data Analysis Program was used to predict the maximum wind speed expected within a 2 to 100-year return period. The Windographer Program is a powerful wind data analysis program that can be used, among other things, for analyzing wind speeds, wind directions (Compass Rose) and extreme winds. The results of the analysis indicate that the maximum wind speeds expected over a 100 year return period is 58 mph (50 knots) over a 10 minute average. Three second wind gusts of up top 81 mph are also expected.[19]

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[18] "Oregon LNG Terminal and Pipeline Project Wind/Current Data Analysis Alignment Alternatives." Page 1.

[19] "Oregon LNG Terminal and Pipeline Project Wind/Current Data Analysis Alignment Alternatives." Table 4. Page 6.

3.3.3 Columbia River Bar

The mouth of the Columbia River experiences extremes in weather and sea conditions that often make conditions treacherous for maritime traffic. This area, referred to as the Columbia River "Bar," extends from Buoy 2 on an inbound ship transit to about Buoy 10 although depending on the wind and sea directions, the hazardous conditions may extend into the river to Buoy 12 . Buoy 2 is outside of the river jetties approximately 4 nautical miles from land at Peacock Spit on the northern and more westerly side of the river mouth, and Buoy 10 is inside the north and south jetties and Buoy 12 is roughly between the Clatsop Spit shoal to the south and Jetty A to the north. The "Bar" is notorious for its strong currents that have been reported as high as 8 knots on a strong ebb tide and treacherous sea conditions, which have been observed in excess of 30 feet on occasion.

In this area, long period ocean swells driven from offshore naturally begin rising higher as the swells start "feeling" the bottom in the shallower water near shore and their period shortens. Seaward of Buoy 2 the ocean bottom is rising from depths of well over 100 feet to the 60 foot depth line between Buoys 2 and 4. On occasion, these rising ocean swells meet conflicting strong ebb currents and possibly conflicting local wind conditions which result in the incoming swells peaking with very short periods making it extremely hazardous for vessels to "cross the bar." These sea conditions may also be combined with low visibility and precipitation that compounds the difficulty of safely navigating/transiting the area.

Accordingly, the U.S. Coast Guard has authority to "close the bar" to vessels when they deem the sea conditions too dangerous for crossing. Pilotage is compulsory for all U.S. ships under Registry and all foreign flag ships except fishing vessels less than 100 feet long or less than 250 gross tons. The Columbia River Bar Pilots specialize in navigating ships through the Columbia River mouth area up to Astoria where "River Pilots" take over for ships going further up river. The Columbia River Bar Pilots may also suspend Pilotage service when the bar conditions are deemed too rough. The decision to suspend service can be a function of concern for delivering a pilot safely to the ship or if they consider the ship incapable of safely transiting in the existing bar conditions. Ship size, horsepower, maneuverability, cargo, and GM if known are all considerations that are taken into account for the decision. The implementation of helicopter delivery has enabled pilot delivery in weather conditions that previously may have prevented a boat delivery. There are still times when wind conditions, sea

conditions, or low visibility preclude the use of helicopter delivery. The Bar Pilots report that they suspend service on average about 11 times per year. This is a rough number however, since it varies widely. As an example, service was not suspended at all in 2004 or 2005, but was suspended 18 times in 2006.

3.3.4 Earthquake/Tsunami

The west coast of the United States is in an active earthquake region. The threat of an earthquake is very real as is the follow-on threat of a tsunami. A tsunami is a series of waves of extremely long wave length and long period generated in a body of water by an impulsive disturbance that displaces the water. While there are other potential sources of a tsunami, this report is primarily concerned with earthquakes that generate the waves. In this case, an earthquake could be fairly near, such as an event on the offshore Cascadia Subduction Zone, which would give little warning if a tsunami was generated, or the earthquake can be distant and travel across the Pacific to the west coast.

As a tsunami leaves the deep water of the open sea and propagates into the more shallow waters near the coast, it undergoes a transformation. Since the speed of the tsunami is related to the water depth, as the depth of the water decreases, the speed of the tsunami diminishes. The energy within the tsunami remains constant, but it transforms by increasing the wave height to offset the decrease in speed. Because of this "shoaling" effect, a tsunami that was imperceptible in deep water may grow to be several feet or more in height.

When a tsunami finally reaches the shore, it may appear as a rapidly rising or falling tide, a series of breaking waves, or even a bore. Reefs, bays, entrances to rivers, undersea features and the slope of the beach all help to modify the tsunami as it approaches the shore. Tsunamis rarely become great, towering breaking waves. Sometimes the tsunami may break far offshore or it may form into a bore: a step-like wave with a steep breaking front.

Coast & Harbor Engineering conducted an analysis of the tsunami threat to the proposed Oregon LNG Terminal site (Appendix V **"**Technical Memorandum: Tsunami Currents and Water Levels at LNG Ship Berth") as part of the FERC permitting requirements. The worst case scenarios reviewed involved major events on the Cascadia Subduction Zone generating a tsunami. Figure 3-5, developed by Mr. Ken

Lilly of Coast & Harbor Engineering, is a plot showing the tsunami water level, speed, and current direction at the proposed LNG mooring.[20] The graph includes three interrelated functions – speed (in feet/second), water level (feet above low-low water) and water flow direction. The water level is used in designing the facility piers by determining the minimum height of the pier and the maximum draft of the vessel so that a vessel will not ground during a tsunami event. The speed of the water is the force of the current pushing or pulling the vessel on or off the pier and direction indicates in which direction the water will be flowing either pushing the vessel onto the pier or pulling it off of the pier.

The plot shows that the tsunami generated current tending to push the moored vessel toward the pier are stronger than those pushing the vessel away from the pier The strongest currents, approximately 7 ft/second or 4 knots, will have a direction of 130 degrees while the back surge will be at a lower speed, approximately 4.5 ft/second or 3 knots, with a direction of approximately 295. Current direction is the direction toward which the current flows in degrees True North.

The plot also shows that the water level (dotted black line) will tend to rise about 7 feet from the existing tide height condition (solid black line) at the time. The lowest tide condition expected as the water subsides is about -0.7 feet. Since the dock height is being planned for 25 feet, the high water level (+ 7 feet) will not cause a problem for the mooring systems. Likewise, with the dredging at the dock planned for 50 feet, the -0.7 foot low water will not result in an LNG vessel grounding at the dock.

20 Coast & Harbor Engineering, “Technical Memorandum Tsunami Currents and Water Levels at LNG Ship Berth”. Figure 4, Page 5.

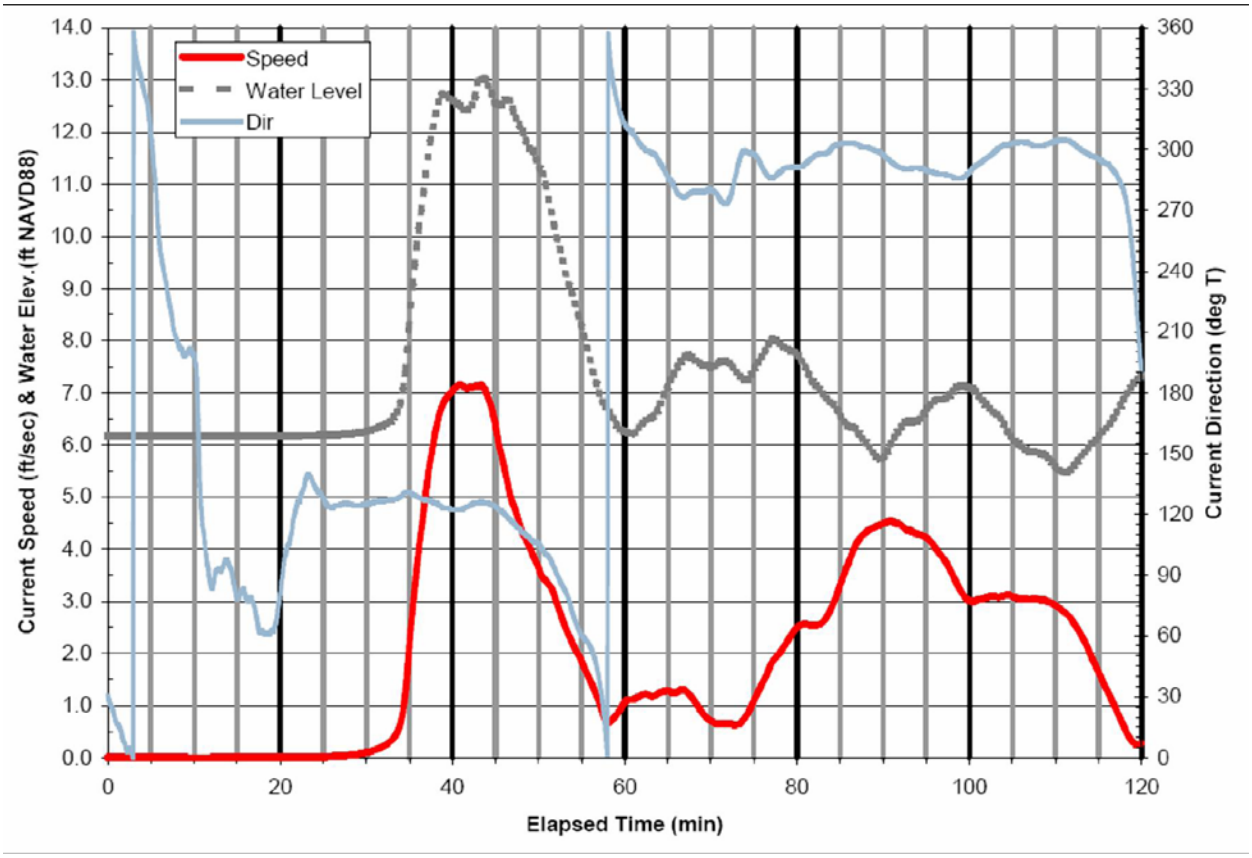

Figure 3-5: Oregon LNG Terminal- Preliminary Tsunami Water Level and Currents at Moored LNG Ship; October 18, 2007

3.3.5 Ship Transit Procedures

(A) ADVANCED NOTICE OF ARRIVAL (ANOA)

All LNG ships will be required to file an ANOA to the National Vessel Movement Center (NVMC) at least 96 hours prior to arrival. In that report, the ship will report information concerning its last port of call, crew manifest, passenger manifest, cargo, the last five foreign port calls, and its' international security certificate among other things. It will be reporting any safety issues, or hazardous conditions aboard, directly to the COTP, such as an inoperative steering pump as an example, which will require the COTP to determine if the ship will be permitted entry with the reported condition.

(B) ADVANCED NOTICE OF ENTRY (ANE)

In addition to the ANOA reported to the Coast Guard, LNG ships may also be required to submit an advanced Notice of Entry (ANE) with the Washington State Department of Ecology at least 24 hours prior to arrival.

(C) COAST GUARD BOARDING

The Coast Guard may board inbound LNG ships approximately 5 nautical miles west of the CR Buoy to verify information submitted in the ANOA, and conduct safety/security inspections. These boardings will normally be completed prior to permitting the ship to proceed into the Columbia River. The boarding team may ride the ship to the dock to provide an additional level of security.

(D) PILOTS

The Columbia River Bar Pilots will also board the ship west of the CR Buoy to take the ship to the dock. They will embark either simultaneously with the Coast Guard or upon completion of the Coast Guard boarding.

(E) TUGS

The tug requirements are addressed in Section 4 of this report and are based on the results of the "Oregon LNG Simulation Report" (Appendix T) conducted at the Pacific Maritime Institute by the Columbia River Bar Pilots. The LNG ships will be met by two tugs in the Columbia River mouth area between buoys 8 and 10 weather permitting. These two tugs will accompany the ship along the ship channel toward the dock with one of them being tethered to the ship. A third, and potentially a fourth tug when maneuvering/docking a Q-MAX class vessel, will meet the ship in the Upper Desdemona Shoals Channel as it approaches the Tansy Point turn.

(F) SECURITY ZONE/ESCORTS

It is anticipated that each loaded, inbound LNG ship will have a security zone established around it much like cruise ships entering the River. It is also anticipated that armed escort boats will be required to enforce the security zone of inbound LNG ships. The proposed security zone and escort requirements are addressed in Sections 4 & 5 of this Report.

3.3.6 Dock Maneuver

(A) MANEUVER TO MOORING

As discussed in Section 3.3.5 above, two tugs will accompany inbound LNG vessels along the ship channel with one of the tugs tethered to the LNG vessel. A third and potentially a fourth tug will meet the ship in the Upper Desdemona Shoals Channel as it approaches the Tansy Point turn. All of the tugs will then come alongside and tether as needed to maneuver the ship to the dock. As a result of the Simulation Study, the Pilots felt that, "… they should always have the option of docking port or starboard side, depending on the conditions. The Pilots decided that the "starboard side to" would likely be the most common maneuver. Starboard side dockings kept the vessel heading into the simulated ebb currents. Additionally the starboard side docking kept the relative angle of the flood current to less than ten (10) degrees off the stern."[21]

(B) DREDGING

As indicated on the charts in Appendix A, there will be a turning basin established north of the planned facility dock. The basin broadens from the dock towards the shipping channel. At its widest point, the turning basin is planned to be approximately 1400 yards. The control depth of this turning basin will be 45 feet. The area immediately around the dock face and out approximately 200 feet will be dredged to 50 ft, to permit more water under the keel while the ships are moored. In the "Oregon LNG Simulation Report" (Appendix T) the Bar Pilots suggest that the basin dredging be extended from the proposed SW corner to the corner of the river channel in position latitude 46 11.31N, Longitude 123 54.54W…"[22] *(Recommendation 7.3.2 (C)(2))*

(C) OBSTRUCTIONS

There are some pilings, both showing above the water and submerged in the area where the pier is proposed for construction. However, the area that would be dredged for a turning basin, north of the proposed dock, is clear of any known cables or obstructions that would hamper dredging or endanger ships maneuvering.

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[21] "Oregon LNG Simulation Report" dated 01/03/2008. Page 6.

[22] "CH2M Hill/Oregon LNG Simulation Report." Revised 01/03/08. Page 8.

3.3.7 Supplemental Navigational Publications

(A) UNITED STATES COAST PILOT 7 (39TH EDITION) 2007

National Oceanic Atmospheric Administration (NOAA) publication that contains information on the Columbia River waterway and supplements the navigational information shown on the above listed NOAA charts.

(B) LIGHT LIST-VOLUME VI, PACIFIC COAST AND PACIFIC ISLANDS (2006 EDITION)

A U.S. Coast Guard publication that provides descriptive information about aids to navigation marking United States coastal and inland waters.

(C) 2007 TIDE TABLES, WEST COAST OF NORTH AND SOUTH AMERICA INCLUDING HAWAIIAN ISLANDS

A McGraw-Hill publication formerly published by NOAA and accepted by the U.S. Coast Guard that provides detailed tide height predictions for 2007.

(D) TIDAL CURRENT TABLES 2007, PACIFIC COAST OF NORTH AMERICA AND ASIA

A McGraw-Hill publication formerly published by NOAA and accepted by the U.S. Coast Guard that provides detailed current predictions for 2007.

3.4 POPULATION CENTERS ALONG THE INTENDED ROUTE

The track line to the proposed facility site dock transits past two small cities located on the Washington side of the Columbia River: Ilwaco and Chinook, and one small city, Warrenton, on the Oregon side of the River. Neither of the Washington State communities are within the Zones of Concern that will be discussed in Sections 4 & 5 of this report. However, the track line does pass within close enough proximity to Warrenton, Oregon and Astoria, Oregon so that those communities are overlapped by the Zones of Concern. The proposed facility is within the Warrenton city limits. Also included in this section is a description of two state parks that are in the vicinity of the track line.

3.4.1 Ilwaco, Washington

The city of Ilwaco is located on the Long Beach peninsula of Washington State and is within Pacific County. It is on Bakers Bay along the north shore of the Columbia

River and bordered to the west by Cape Disappointment State Park and the Pacific Ocean. The city spans an area of 2.4 square miles and has a population of approximately 950 people based on the 2000 census data for a population density of 462 people per square mile. According to the City of Ilwaco web site, the number of people in the city may swell to approximately 3000 in the summer months. The Port of Ilwaco is not a deep water port but has a large marina that provides berths for many recreational and commercial fishing vessels. There is a narrow dredged channel that leads from the main channel part of the Columbia River north approximately three nautical miles along the west side of Sand island to the Port of Ilwaco. The Zones of Concern from a transiting LNG ship do not overlap the city.

3.4.2 Chinook, Washington

A small, unincorporated community within Pacific County, Washington, located on the west side of Bakers Bay on the north shore of the Columbia River. The community spans an area of slightly more than 1 square mile and has a population of 457 according to 2000 U.S. Census data. It has a population density of 446 people per square mile based on that census data.[23] The primary business is fishing and tourism. The Port of Chinook has 300 boat slips for commercial and recreational vessels. The boats can access the Columbia River through a small dredged boat channel leading through Bakers Bay to the deeper water of the Columbia River. The Bell Buoy Crab Company is a major employer in this community and one of the largest crab processing plants in the state of Washington. The Zones of Concern from a transiting LNG ship do not overlap the city.

3.4.3 Warrenton, Oregon

Warrenton is located along the south shore of the Columbia River between the Fort Stevens State Park and the city of Astoria. It is within Clatsop County. The proposed site for the LNG facility is within the Warrenton city limits. Warrenton includes the former communities of Fort Stevens, Oregon and Hammond, Oregon. The population was 4,096 at the 2000 census. The 2006 Oregon Population Report generated by the Portland State University indicates that the population was 4,460 in 2006.[24] According to the U.S. Census Bureau the city has a total area of 43.3km^2 (16.7

[23] Wikipedia, Chinook, Washington
[24] 2006 Oregon Population Report, Population Research Center

mi²) of which 31.9 km² (12.3 mi²) is land and 11.3 km² (4.4 mi²), or 26.15% of it is water. The resulting population density is 363 persons/square mile. The western end of the city waterfront includes the Hammond Marina while the area around Tansy Point is primarily a light industrial area. Warrenton has two marinas, one is the Hammond Marina which is on the Columbia River and the other is in the Skipanon Waterway.

3.4.4 Astoria, Oregon

Astoria is located along the south shore of the Columbia River roughly between Mile 12 and Mile 20 of the river. The population was 9,813 according to the 2000 census data. The 2006 Oregon Population Report generated by the Portland State University indicates that the population was 9,970 in 2006.[25] Astoria has a total area of 10.6 square miles of which 6.1 square miles is land.[26] As such, the population density is about 1635/square mile. That population is primarily concentrated on the western side of the city as indicated on the charts provided in Appendix A. The Port of Astoria has three main piers and two marinas. Also within the city limits is the southern end of the Astoria-Megler Bridge which spans the Columbia River connecting Oregon and Washington.

3.4.5 Cape Disappointment State Park

The Cape Disappointment State Park, formerly known as Fort Canby State Park, covers 1,882 acres of the southern most tip of the Long Beach peninsula in Washington State. The park includes the north jetty which defines the north side of the Columbia River entrance. The park has approximately 250 camp sites and several cabins. Cape Disappointment lighthouse and the North Head lighthouse are both within the state park. During the summer months from June to September, the number of people visiting the park routinely swells to a capacity of about 5,000 per day. There is a public boat ramp at Fort Canby on the west side of Cape Disappointment.

[25] Ibid.

[26] Wikipedia, Astoria, Oregon

3.4.6 Fort Stevens State Park

The Fort Stevens State Park covers 3700 acres and also gets a large number of visitors in the summer months. There are almost 500 camp sites in the park for trailers and tents and 15 "yurts," which are essentially round shaped cabins, to rent. While there are relatively few visitors in the winter months, during the summer, from June to September, the park campsites are full of vacationers. On most days in the summer, the park reaches a capacity of about 5,000 visitors per day. A majority of those people remain in the southern area of the park where the campsites are. Many will visit the northern Clatsop Spit to view the jetties and beach, but due to the relatively cool temperatures, the ranger stated that the visitors do not generally stay in that northern spit long.

3.5 ZONES OF CONCERN AND POPULATION DENSITY CRITERIA

NVIC 05-05 describes Zones of Concern that are to be used for LNG ships as a means to derive a consequence and assess the risk involved with transporting the LNG cargo. The zones are based on the recommendations of the Sandia National Laboratories Report titled, Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water.

The mathematical modeling data provided to develop the Zones of Concern by the Coast Guard was based on the size of LNG tankers being used in industry as of that time. The largest tanker had a capacity of 148,000 cubic meters of LNG and the cargo tank sizes were 25,000 cubic meters. Since that time larger ships have been designed and are being built. The largest ships, Q-MAX class, as reflected in Table 3-1, have a cargo capacity of 263,000 - 266,000 cubic meters of LNG and have tank sizes of 40,000 cubic meters. A new Sandia report to analyze the newer/larger ships is currently in draft form going through interagency review.

Mr. Mike Hightower, from Sandia, indicated over the telephone that the draft report reflected a growth in the Zones of Concern of less than ten per cent of the current NVIC 05-05 zones. With the understanding that the report is not final and that the Coast Guard may decide to place different zone distances or criteria to the next change of the NVIC, it was decided for this report to increase each of the Zones of Concern approximately 12 percent from the current zones in NVIC 05-05.

The intent of expanding the Zones of Concern by 12 percent in this report is to expedite the review process to use the newer, larger "Q-MAX" LNG ships at the proposed facility when they are brought into service. If the "new" published zones are within this 12 percent increase, it would be reasonable for the COTP Portland to use the information in this report as the basis for the decision regarding the suitability of the waterway for the use of the Q-MAX ships. If the new zone sizes extend beyond this anticipated amount of 12 percent, or the Coast Guard significantly changes the waterway suitability determination criteria, the approval/disapproval decision will pertain to the existing LNG ship sizes of 148,000 cubic meters that were modeled in the 2004 Sandia Report and further justification will be necessary for the larger ships as determined by the COTP, Portland, OR.

3.5.1 Zones of Concern (as Defined in NVIC 05-05)

Zone 1: This is the area with the most severe potential consequences around the LNG tanker. It is the area where an LNG spill could pose a severe public safety and property hazard and could damage or significantly disrupt critical infrastructure and key assets located within this area. Zone 1 is considered to extend about 500 meters (0.3 miles) for an intentional breach of an LNG tanker. It is based on a predicted thermal intensity of 37.5kW/m2 at that outer range. The Sandia Report indicates that thermal intensity could cause significant damage to structures, equipment, and machinery after exposure of about 10 minutes. Risk management strategies in this zone should address vapor cloud dispersion and fire hazards. The most rigorous deterrent measures should be considered when major critical infrastructure elements, such as population or commercial centers, lie within Zone 1. These measures should include such things as vessel security zones, waterway traffic management, and establishment of positive control over vessels. Coordination among all port security stakeholders is essential. Incident management and emergency response measures should be carefully evaluated to ensure adequate resources (i.e., firefighting, salvage, etc.) are available for consequence and risk mitigation.

Zone 2: This is an area with less severe consequences than Zone 1 and is considered to extend from 500 meters (0.3 miles) to 1,600 meters (1 mile) from the LNG tanker. Within this zone the thermal intensity is predicted to decline from the 37.5kW/m^2 to 5kW/m^2 at the outer edge if the zone. The Sandia Report (page 38) cites a National Fire Protection Association standard that the heat flux value of 5kW/m^2 is the design level for property lines or in areas where groups of more than 50 people might

assemble. Risk management strategies in this zone should address vapor cloud dispersion and fire hazards. When major critical infrastructure elements occur within Zone 2, risk management strategies that should be considered include incident management and emergency response measures that ensure areas of refuge (enclosed areas, building) are available, the development of community warning procedures, and education programs to ensure that communities are aware of precautionary measures.

Zone 3: This is an area with the least likelihood of severe consequences and is considered to extend from 1,600 meters (1 mile) to a conservative maximum of 3,500 meters (2.2 miles) from the LNG tanker. This zone was conceived to account for the highly unlikely event that three cargo tanks were breached simultaneously and a vapor cloud dispersed without initial ignition. Risk management strategies in this zone should address the vapor cloud dispersion hazard. When major critical infrastructure elements occur within Zone 3, risk management strategies that should be considered include incident management and emergency response measures that ensure areas of refuge are available and community education programs should be considered to ensure that people know what to do in the unlikely event of the release of a vapor cloud without initial ignition. It is noted that this zone was established based on a three hole, cascading scenario that was modeled as if all three five square meter holes breached simultaneously. Sandia called the event “unlikely.”

3.5.2 “Expanded” Zones of Concern

Zone 1: Considered to extend 560 meters (0.35 miles) for an intentional breach of an LNG tanker. A 60-meter extension to the current Zone 1 range. All of the risk management strategy provisions for the current NVIC Zone 1 apply.

Zone 2: Considered to extend from 560 meters to 1800 meters (1.1 miles). This is a 200 meter extension to the current Zone 2 range. The same risk management considerations/provisions for the current NVIC Zone 2 described above apply.

Zone 3: Considered to extend from 1800 meters to 4000 meters (2.5 miles). This is a 500 meter extension to the current Zone 3 range. The same risk management considerations/provisions for the current NVIC Zone 3 described above apply.

3.5.3 Population Density (Criteria Defined in NVIC 05-05 and not Affected by the Change to the Zone Size)

High – Areas with 9,000 people/square mile or more.

Medium – Areas with greater than 1,000 but less than 9,000 people/square mile.

Low – Areas with less than 1,000 people/square mile.

3.5.4 Land Areas Overlapped by Zone 1 (Using the Expanded Zone Ranges)

The areas described in the following narrative sections can be viewed in both the nautical charts in Appendix A and in the Google Earth images that have the zones of concern superimposed on them in Appendix B. Both the current Zones of Concern published in NVIC 05-05 and the expanded zones are displayed for comparison purposes. The Zones closer to the track line are the NVIC 05-05 zones and the ones further are the "expanded zones" for the larger LNG vessels. The lines are color coded for ease in identifying the zones.

(A) HAMMOND MARINA POINT

The track line passes 550 yards (503m) off of the point of land on the north side of Hammond Marina. Therefore, Zone 1 overlaps the shore by 57 meters (560 meters – 503 meters). However, the area of the Marina overlapped by Zone 1 does not have any permanent residences. It is a park area with a parking lot along the shore. Beyond the Zone 1 area is an area with approximately 20 parking spots for self-contained campers that are managed by the marina. While there are clearly more visitors in the area in the summer months, the overlap area is considered a low populated area. (Note - This parking area was not in Zone 1 using the standard zone size.)

(B) TANSY POINT

The track line passes 400 yards (366m) off of Tansy Point. The Zone 1 overlap begins just north of the Warrenton Fiber wood chip facility, between a small housing area and the facility. The Zone 1 line crosses over the shoreline very near but just south of some new residences built on the shoreline. Approximately a third of the Warrenton Fiber property is within the zone. Warrenton Fiber is a wood chip facility and much of its property is open storage for the lumber. Structures containing the chipping equipment and offices are also within Zone 1 as well as the docks where a barge is often moored to load wood chips. The area of overlap is considered low population. (Note – This area was overlapped by Zone 1 under the current zone sizes, but not as much of Warrenton Fiber. While the expanded Zone 1 is closer to the residences to the north of Warrenton Fiber, they are not in it.)

(C) EAST SKIPANON PENINSULA

When moored, the ship is 560 yards (512m) from the shoreline of the Skipanon Peninsula where the LNG receiving facility would be located. It is considered a low population area. (Note – This area was not in Zone 1 using the standard zone size.)

3.5.5 Land Areas Overlapped by Zone 2 (Using the Expanded Zone Ranges)

(A) CAPE DISAPPOINTMENT STATE PARK

The track passes within 1200 yards (1097m) of the North Jetty and approximately 1650 yards (1509m) from where the beach meets the North Jetty. Recognizing that the state park does increase in its visitors in the summer to the point that it affects the population category, they are largely in the camping areas further to the north. The approximately 300m overlap of the state park is considered low population. (Note – This North Jetty was overlapped by Zone 2 under the current zone sizes, but very little of the beach. The additional 200m in range of Zone 2 is comprised of the beach at the southern tip of the park.).

(B) JETTY A

The track passes within 706 yards (640m) south of Jetty A. Zone 2 overlaps the jetty by approximately 1160 m, which is almost the entire jetty, but does not reach land on Cape Disappointment. While is could be considered a land mark that has no population at all, there may be an occasional person venturing out on the jetty to fish, so it was considered as low population. (Note – The jetty was overlapped by Zone 2 of the current (NVIC) zone sizes but 200m less of the jetty than with the larger zones.)

(C) SAND ISLAND

The track passes to within 1400 yards (1280m) of the southern tip of Sand Island. Zone 2 overlaps the island by approximately 520m. This island is uninhabited, but since there may be someone visiting by boat, it is considered low population.

(D) CLATSOP SPIT

The track passes to within 650 yards (595m) of the northern head of Clatsop Spit which causes an overlap of Zone 2 of approximately 1205m of the eastern half of the point of land. Jetty Lagoon separates the northern head of Clatsop Spit with the southern part of the peninsula where the populated part of Warrenton and Fort Stevens

State Park begins with respect to the Zone 2 overlap. The northern part of Clatsop Spit is considered low population. All of Fort Stevens realizes a surge in people visiting the park in summer months, but those vacationers primarily remain to the south. There will be an increase in sightseers but not to the extent that it would change the population density determination.

(E) WARRENTON

As the track transits along Desdemona Channel it goes past the shoreline of Warrenton. As described in Section 3.5.4 above, Zone 1 overlaps two parts of that shoreline and it is relatively close to shore in the rest of this area to Tansy Point where the track line turns to the east. Therefore, the Zone 2 overlap of land along the Warrenton coastal area bordering the Columbia River extends from Jetty Lagoon south to Tansy Point by about 1200m on average and less over the western Skipanon Peninsula area where the ship track turns to the east. As can be clearly seen in the Google picture in Appendix B, a majority of the population in the area north of Tansy Pt is within Zone 2. The additional 200m from the expanded zone size did include a number of houses in the housing area to the west of Hammond Marina that were not within the standard Zone 2. Also there were some additional houses included southwest of Tansy Point. The additional Zone 2 size increase the amount of property covered at the Weyerhaeuser Plant, but most of the buildings remain on the outside of Zone 2. The Warrenton area overlapped by Zone 2 is considered a low population area except during summer. As is the case with Ft. Steven State Park, the summer influx of vacationers and fishermen increases the population density to medium for the area north of Tansy Point. The area overlapped by Zone 2 south of Tansy Point includes the Skipanon Peninsulas which is largely industrial, as can be viewed in the Google Earth pictures in Appendices B and C. It is not expected that this population will change significantly during the year and remains categorized as low.

3.5.6 Land Areas Overlapped by Zone 3 (Using the Expanded Zone Ranges)

(A) CAPE DISAPPOINTMENT STATE PARK

Zone 3 overlaps approximately the southern two thirds of the state park. It extends 2625 yards (2400m) north from the southernmost tip of land at the Pacific Ocean shoreline and cuts across the park on a east-north-east line to Bakers Bay approximately 500 yards south of the park boundary with the City of Ilwaco. The outer boundary of the expanded Zone 3 encompasses camp sites 1-60 of camp ground A,

bisects camp ground B with camp sites 61-120, and includes camp ground D with camp sites 181-250 and cabins. Camp ground C with camp sites 121-180 is outside of Zone 3. Fort Canby with the Coast Guard Station and the Coast Guard Motor Lifeboat training facility are within Zone 3. The smaller, standard NVIC 05-05 Zone 3 would not reach the camp sites in campground A or B, but would include D. The area is considered low population except during the summer months from June to September when the population swells to a medium level.

(B) SAND ISLANDS IN BAKERS BAY

There are three islands to the east of Cape Disappointment in Bakers Bay. All three are entirely within the expanded Zone 3. Two of the islands are named “Sand Island” on the nautical chart. The larger of the three is closer to the track line also has some Zone 2 overlap at its southern tip as discussed in the previous section. All three islands are uninhabited.

(C) CLATSOP SPIT/FORT STEVENS STATE PARK

Zone 3 overlaps the entire southern jetty and the east side of Clatsop Spit. As can be seen in the nautical chart and Google pictures in Appendices A, B and C, Zone 3 overlaps the eastern beach area of the northern head of Clatsop Spit, all of the “neck” of the spit that is west of Jetty Lagoon, and most of the southern area of the state park, including the camping areas that have 495 camp sites, including the tent spaces, and 15 yurts (cabins). The area is considered low population except during the summer months from June to September when the population swells to a medium level.

(D) WARRENTON

Southeast of Fort Stevens State Park, Zone 3 extends the full distance form the Zone 2 limit overlapping a swath over Warrenton south to the airport and out into Youngs Bay. As seen in the Google Earth pictures in Appendix B, much of the land is woodlands with few residences. However, in the southern area in particular, Zone 3 overlaps the central area of Warrenton and the airport to the southeast. There are some additional residences included by expanding Zone 3. The current NVIC Zone 3 would not overlap the grade school but the school does fall within the outer reach of the expanded zone. The 2000 U.S. census indicates that the city of Warrenton has a population density of less than 1,000 persons per square mile and is considered a low population area in accordance with NVIC 05-05. However, the participants at the Risk

Assessment Workshop argued that during the summer tourist months the population of Warrenton well exceeded 1,000 persons per square mile. Therefore, most of the city of Warrenton was treated as a medium density population during the summer months (June – September).

(E) ASTORIA

Zone 3 extends to the western side of Astoria when the ship approaches and is moored to the dock. As illustrated in the Google Earth pictures, the zone is described by an arc that extends from the high school northerly across Astoria until it reaches the Columbia River approximately 75 yards east of the Astoria-Megler Bridge. Approximately 3000 yards, or about one and a half miles, of the southern half of the bridge is overlapped by the outer edge of the expanded Zone 3. The standard NVIC Zone 3 does not overlap the bridge but does overlap residential areas of Astoria albeit to a lesser amount than the expanded zones. The population density within this part of Astoria is considered medium year round.

3.6 CRITICAL INFRASTRUCTURE

The Astoria-Megler Bridge is the only critical infrastructure listed by the Coast Guard that would fall within the Zones of Concern ranges of an inbound LNG ship transiting and moored to the proposed Oregon LNG Terminal. The bridge is the longest continuous cantilever truss bridge in the world, spanning approximately four miles across the Columbia River from Astoria, Oregon to Point Ellice, Washington. The bridge connects Highway 101 between the two states. It has a horizontal span of 1070 feet to accommodate the main shipping channel and a vertical clearance of 206 feet at the center of the span.

The intended track line to the facility does not extend upriver to the bridge, but ends within 4100 yards (3749m) of the nearest point to the bridge. That would place a portion of the bridge within Zone 3 for the Expanded Zones of Concern described for the largest ships. For the zones described in NVIC 05-05 for the 148,000 cubic meter ships and below, the zones would not reach the bridge.

3.7 ASTORIA REGIONAL AIRPORT

3.7.1 General Overview

The Astoria Regional Airport facility is approximately 2 miles south of the proposed terminal moorings. The airport operations currently involve general aviation and military flight operations. The airport falls under the purview of the Port of Astoria. The Port Authority is attempting to attract some commercial activities in the future to provide flights to/from Portland. The airport has two runways that are maintained and a third that is not maintained. According to the 2007 Airport Master Record, there are 43 single engine aircraft based at the airport, 6 multi-engine, 1 civilian helicopter, 2 ultra-lights, and 3 military/Coast Guard helicopters.

3.7.2 Runway Descriptions

Runway names are based on the magnetic headings of the air strip. Runway 08/26 is 5796 feet long and is equipped for IFR operations. Runway 13/31 is 4996 feet long and is limited to VFR only. The third runway is not maintained but is available and is used occasionally for emergency landings if the wind or weather conditions do not permit use of the other two airstrips. Runway 31 heads roughly in a 310 magnetic heading (315M/334T) has a flight path that is in the general direction of the terminal dock at a range of approximately 1.6 miles (8540 feet) at its nearest point.

3.7.3 Airport Operations

The airport is used by general aviation and military aircraft. According to the 2007 FAA Master Record aircraft operations (take offs and landings) over a 12 month period included 1000 air taxi operations, 16,300 local general aviation operations, 15,800 itinerant flights (visiting aircraft), and 20,000 military operations. The civilian helicopter at the airport is used largely for air taxi operations transporting the Columbia River Bar Pilots to/from ships.

3.7.4 Military Operations

Coast Guard Group/Air Station Astoria is located at the airport with 3 HH-60 helicopters permanently based there. Helicopter operations are conducted by the Coast Guard either for training or operational missions on a daily basis. There are also visiting fixed wing Coast Guard aircraft as well as Air National Guard aircraft. The largest aircraft flying into the airfield are C-130s although those flights are infrequent. The

larger fixed wing aircraft will normally use Runway 08/26 for landing/take-off unless the prevailing wind direction mandates otherwise.

3.7.5 LNG Terminal Location Considerations

While the location of the LNG terminal dock is generally aligned with the 13/31 runway (the 31 direction), it is about 1.6 miles away. Aircraft using that runway are usually small general aviation aircraft using VFR. The tanks planned for the terminal and the mast height (air draft) of the larger ships expected to moor at the dock are both within the height/distance criteria that require notification of the FAA as prescribed in 14CFR77. The dock where the ships would moor is within 10,000 feet of the runway. The largest ships, the Q-Max design, are expected to have masts with vertical heights of approximately 174 feet which is the horizontal plane extending out 10,000 feet from the runway described in the CFR above which is the basis for determining if an object is an obstruction to air navigation. An “obstruction” is not the same as a “hazard” to air navigation. An obstruction doesn’t stop air navigation in the area, but the nature and location of the obstruction will need to be publicized to make pilots using the airport aware. A determination and approval will be needed from the FAA prior to construction of the terminal and operations by the larger LNG ships being considered.

3.7.6 Identification of Sensitive Environmental Areas (TBD)

This section describes the federal and state listed threatened and endangered species that may occur within the Zones of Concern. The list includes species that are federally listed, state listed, and marine mammals that are protected under the Marine Mammal Protection Act. The list was generated from a table provided by the U.S. Fish and Wildlife Service for Clatsop County, the Oregon Department of Fish and Wildlife, and the Washington Department of Fish and Wildlife. Fish species are not included in this listing due to their ability to easily seek protection from surface disturbances. Incidents within the Zones of Concern will unlikely affect fish species. Species that may be impacted are listed in Table 3-6. Brief summaries of habitat requirements and potential for impact to endangered or threatened species are provided. Detailed information on the life histories and habitats for listed species, analysis of potential impacts, and proposed mitigation measures are provided in Oregon LNG’s Resource Report 3. Documentation in Resource Report 3 will be further developed in the Biological Assessment and Environmental Impact Statement.

Table 3-6:
List of Special-status Birds, Reptiles, Amphibians, and Mammals Potentially Found in the Vicinity of the Zones of Concern

Scientific	Common	Federal Status*	State Status*	Habitat	Likely Present in Zones of Concern
Birds					
Haliaetus leucocephalus	Bald eagle	D	ST (OR, WA)	Forests near streams and lakes	Y
Pelecanuclvisc cs occidentalis	Brown Pelican	FE	SE (OR, WA)	Coastal and Estuarine, nesting on rock outcrops off coast	Y No known nesting
Bucephala albeola	Bufflehead	--	SU (OR)	Shallow saltwater	Y No known nesting
Histrinicus histrionicus	Harlequin duck	FSC	SU (OR)	Rocky coast	Y No known nesting
Brachyramphus marmoratus	Marbled murrelet	FT	ST (OR, WA)	Marine-- foraging Interior old-growth trees-- nesting	Y No known nesting
Oreortyx pictus	Mountain quail	FSC	List 4 (OR)	Shrubby vegetation, Mountain	N
Strix occidentalis caurina	Northern Spotted Owl	FT	ST (OR), SE (WA)	Inland forest, primarily old-growth	N
Contopus cooperi	Olive-sided flycatcher	FSC	SS (OR)	Coniferous forest	Y
Progne subis	Purple martin	SOC	SC (OR), SCA (WA)	Nests in cavities that may be found in abandoned piers	Y
Falco peregrinus anatum	Peregrine falcon	D	SE (OR)	Nesting on cliffs and bridges	Y
Phoebastria albatrus	Short-tailed Albatross	FE	SCA (WA)	Pelagic	N
Charadrius alexandrinus	Snowy plover	FT	ST (OR), SE (WA)	Coastal	N
Eremophila alpestris strigata	Streaked horned lark	FC	SC (OR) SE (WA)	Prairie, grasslands	N
Pooecetes gramineus affinis	Vesper sparrow	SOC	SC (OR), SCA (WA)	Prairie, grasslands	Y

Scientific	Common	Federal Status*	State Status*	Habitat	Likely Present in Zones of Concern
Mammals					
Orcinus orca	Killer whale	FE	SE (WA)	Marine	Y
Balaena glacialis	Right whale	FE	SE (OR, WA)	Marine	Y
Balaenoptera borealis	Sei whale	FE	SE (OR, WA)	Marine	Y
Balaenoptera musculus	Blue whale	FE	SE (OR, WA)	Marine	Y
Balaenoptera physalus	Finback whale	FE	SE (OR, WA)	Marine	Y
Megaptera novaeangliae	Humpback whale	FE	SE (OR, WA)	Marine	Y
Physeter macrocephalus	Sperm whale	FE	SE (OR, WA)	Marine	Y
Eumetopias jubatus	Steller sea lion	FE	ST (WA)	Marine	Y
Zalphus californianus	California sea lion	--	--	Marine	Y
Phoca vitulina	Harbor seal	--	--	Marine	Y
Mirounga angustirostris	Elephant seal	--	- -	Marine	Y
Myotis thysanodes	Fringed myotis	FSC	SV (OR)	Montane forest	N
Myotis volans	Long-legged myotis	FSC	SU (OR)	Montane forest	N
Corynorhinus townsendii	Townsend's big-eared bat	FSC	SC (OR), SCA (WA)	Montane forest	N
Arborimus albipes	White-footed vole	FSC	SU (OR)	Temperate forest	N
Reptiles and Amphibians					
Chelonia mydas	Green sea turtle	FT	SE (OR), ST (WA)	Marine	Y
Dermochelys coriacea	Leatherback sea turtle	FE	SE (OR, WA)	Marine	Y
Lepidochelys olivacea	Olive (Pacific) ridley sea turtle	FT	ST (OR)	Marine	Y
Carretta carretta	Loggerhead sea turtle	FT	ST (OR, WA)	Marine	Y
Chrysemys picta	Painted turtle	--	SC (OR)	Aquatic-freshwater	N
Actinemys marmorata marmorata	Northern Pacific pond turtle	FSC	SC (OR)	Aquatic-freshwater	N

Scientific	Common	Federal Status*	State Status*	Habitat	Likely Present in Zones of Concern
Reptiles and Amphibians					
Dicamptodon copei	Cope's giant salamander	--	SU (OR)	Aquatic-freshwater	N
Rana aurora aurora	Northern red-legged frog	FSC	SV/SU (OR)	Aquatic-freshwater	N

*Status Codes:

Federal Threatened and Endangered Species
FE – Federal Endangered Species
FT – Federal Threatened Species
FP – Federal Proposed Species for Listing as Threatened or Endangered
FC – Federal Candidate to become a Proposed Species
FSC – Federal Species of Concern
SLC – Federal Species of Local Concern
D – Federal Delisted Species

Oregon Special-Status Species
SE – Oregon State Endangered Species
ST – Oregon State Threatened Species
SC – Critical
SS – Sensitive
SV – Vulnerable
SP – Peripheral or Naturally Rare
SU – Undetermined status; status unclear
List 2 – Threatened, Endangered, or Extirpated from Oregon, Secure Elsewhere
List 4 – State Watch List

Washington Special-Status Species
SE – Washington State Endangered Species
ST – Washington State Threatened Species
SCA – State Candidate
SC – State Critical
SV – State Vulnerable
SP – Peripheral or Naturally Rare
SU – Undetermined status; status unclear

Birds:

Nests and fledging birds would be most susceptible to impacts from a catastrophic event to a LNG vessel. Presumably, mature birds would fly from intolerable heat. Potential impacts would be greatest when migratory or nesting birds are present within Zone 1.

Bald Eagle. Bald eagles nest in tall trees and snags along rivers and streams. There are several bald eagle nest sites along the banks of the Columbia River between the Terminal and the mouth of the river

Brown Pelican**.** Brown pelicans nest in large colonies on inaccessible rock outcrops near the coast. Brown pelicans are frequently observed in the Lower Columbia River estuary, off the northern end of the Skipanon Peninsula, and in Youngs Bay during the summer months. Nesting habitat is not located within the Zones of Concern.

Marbled Murrelet. Marbled murrelets forage in the estuary and in the Pacific Ocean. They nest in in-land old-growth trees. The limiting factor for the marbled murrelet is suitable nesting habitat on land. Preliminary reviews suggest that there is no suitable nesting habitat within Zones 1 and 2.

Northern Spotted Owl. Habitat characteristics for the northern spotted owl, a threatened species, are complex and generally include late successional forests, forests with multiple layers, moderate to closed canopies, space open for flying below the canopy, large snags, and dead wood on the ground. Preliminary reviews suggest that there is no suitable habitat within the Zones of Concern.

Snowy Plover. Snowy plovers require open, unvegetated, unstable sand areas for nesting. They commonly nest on sand beaches along the Pacific Ocean, and they are occasionally found nesting on sand spits near the terminus of rivers. The Pacific Coast population includes individuals that nest adjacent to tidal waters of the Pacific Ocean. None of the known nesting locations are within the Zones of Concern.

Peregrine Falcon. American peregrine falcons (*Falco peregrinus)*, once a Federally listed endangered species, typically nest in high spots such as cliffs, bridges, and tall buildings. The lack of suitable nest sites is the primary limiting factor for peregrine falcons. There is a known nest location greater than 1 mile from the Terminal in Astoria.

Short-tailed Albatross. The short-tailed albatross is a pelagic species that may occur off the Oregon and Washington coasts. They are unlikely to occur within the Zones of Concern.

Marine Mammals:

There are seven whale species and four seal and sea lion species of concern potentially occurring in the zones of concern. These are migratory marine species with the ability to travel large distances away from any potential fire or disruption related to the LNG facility.

An exception is seal and sea lion haulouts near the terminal (Table 3-7).

Table 3-7:
Seal and Sea Lion Haulout Locations in the Terminal Vicinity *

Location	Latitude	Longitude	Species	Description
Tip of South Jetty	46 14.03	124 03.94	Steller Sea Lion, Harbor Seal, California Sea Lion	Year-round on concrete slabs and rock rubble. Abandoned during high ocean swell.
Chinook/Baker Bay	46 15.90	123 57.89	Harbor Seal	Chinook Channel area. Intermittent use at low tides.
Chinook/Baker Bay	46 15.74	123 57.63	Harbor Seal	On shoals northwest of entrance channel. Intermittent use at low tides.
Desdemona Sands	46 12.80	123 55.90	Harbor Seal	Shoal to the west of Astoria/Megler bridge. Alternate site used intermittently.
Desdemona Sands	46 13.19	123 53.61	Harbor Seal	Shoals west of Astoria/Megler bridge. Alternate site used intermittently on extreme low tides.
Desdemona Sands	46 12.73	123 53.33	Harbor Seal	Shoals west of Astoria/Megler bridge. Main lower river haulout.

* Source: Washington Department of Fish and Wildlife, Wildlife Science Division. February 2000. *Atlas of Seal and Sea Lion Haulout Sites in Washington*. (http://wdfw.wa.gov/wlm/research/papers/seal_haulout).

Reptiles and Amphibians:

Several sensitive species of marine turtles exist within the zones of concern. Like whales, seals, and sea lions, marine turtles may travel from surface disruptions related to the LNG vessel traffic. Sea turtle are not known to nest on the coasts of Oregon and Washington. They are not known to occur within the Columbia River estuary.

4. RISK ASSESSMENT (SAFETY AND SECURITY)

This section of the WSA identifies and analyzes safety and security risks that arise from the introduction of LNG operations onto the Columbia River and at the proposed terminal location at Warrenton. It addresses conditions or incidents that could result in a release of cargo either through accidental or intentional acts. The intent of this section is to systematically address the risks involved in establishment of an LNG Terminal at Warrenton for a series of possible scenarios. Risk Scores are developed for each of the safety and security scenarios. In the security scenarios, Risk Scores are calculated for each of the three MARSEC Levels. In the next Section, "Section 5: Risk Management Strategies", we will discuss specific strategies/measures to address the identified risks.

4.1 RISK ASSESSMENT PROCESS

The Risk Based Decision Making ("RBDM") techniques, "Change Analysis" and "What If", were used in this assessment to provide a systematic method of risk analysis. "Change Analysis" is a qualitative, "systems," based approach intended to review the overall operational impact of the new ships and terminal on the port and overall maritime transportation system (MTS) in the region. The "What If" methodology is a more specific, scenario-based, quantitative technique that permits categorizing and ranking risks. The "What if" format is used to address both the accidental release scenarios and intentional release scenarios.

The standard RBDM method of determining risk for both accidental and security scenarios is done by using a common formula: Risk = Probability X Consequence. However, determining "probability" is very different for accidental scenarios versus incidents caused by intentional acts. The probability of an accidental incident is based on historical data. Probability of an intentional act causing an incident is determined by multiplying threat times vulnerability, or Probability = Threat X Vulnerability.

In accordance with NVIC 05-05, "Consequence" is a function of shore side population areas overlapped by the "Zones of Concern" defined in the Sandia Report as discussed in Section 3.5 above. As a first step in determining "Consequence" for the

different scenarios, a track line, developed with the input and assistance of the Columbia River Bar Pilots, was drawn on a nautical chart. The track line, as per NVIC 05-05, begins at the 12 nautical mile limit and then passes through the United States territorial seas to the Columbia River entrance and then up the river to the facility mooring. It is recognized that the Columbia River Bar pilots may board the ships further out than 12 nautical miles, depending on where the ship is located at the time of arrival by the pilots. This track line is representative of a "typical" location which is approximately 6-7 nautical miles west of the CR Buoy. Next, population densities were superimposed on the chart using the 2000 U.S. Census data. (Note: As a result of the input of the participants of the Risk Assessment Workshop conducted on October 31, 2007, the population densities were modified to account for the large influx of visitors during the summer months. This is discussed in Section 4.1.1 below.) Critical infrastructure and key assets along the intended track were identified based on information provided by COTP Portland. Finally, the "Zones of Concern" identified in the Sandia Report and the "Expanded Zones of Concern" discussed in Section 3.5.2 above, were overlaid onto the charts to indicate areas where the Zones of Concern overlap populated land areas and critical infrastructure. The charts showing the track line with the Zones of Concern superimposed are found in Appendix A. Similarly, Google Earth snapshots of the transit area with the track line and zones superimposed are found in Appendix B in order to better visually illustrate what is being overlapped by the zones ashore.

4.1.1 Population Densities

Population densities, based on the 2000 U.S. Census, were plotted on electronic nautical charts using a GIS system. NVIC 05-05 states that, "Population density – for the purpose of this assessment, population density may be broken into two categories. High density populations are areas where the population is 9,000 persons per square mile or greater. Medium density populations are defined as 1,000 to 9,000 persons per

square mile."[27] We have indicated any areas with population densities of less than 1,000 per square mile as "Low Population" areas.

As shown on the charts in Appendix A, the population density on either side of the Columbia River, from the mouth of the River up to the proposed terminal is a low population density area. However, during the Risk Assessment Workshop held in Warrenton, OR on October 31, 2007, the participants suggested that the City of Warrenton and the State Parks at the entrance to the Columbia River, Fort Stevens and Cape Disappointment, should be treated as medium population density areas during the summer months to address the large influx of tourists during that time. The Halcrow representatives had already confirmed with the State Parks that the number of visitors in the Parks expanded to upwards of 5,000 per day during the summer season. Therefore, the Charts in Appendix A were plotted using the official U.S. Census data; however, in our risk calculations, we treated portions of the City of Warrenton and two State Parks as medium density population areas during the busy summer months.

4.1.2 Zones of Concern

As discussed in Section 3.5 of this WSA, the Coast Guard NVIC 05-05 Zones of Concern are based on the results of the 2004 Study completed by Sandia that conducted modeling using LNG ship sizes being used at the time of that study. The existing Zones in NVIC 05-05 extend out from the ship 500 meters, 500 meters to 1,600 meters, and 1,600 meters to 3,500 meters, reflecting a progressive hazard severity ranging from a serious thermal hazard in Zone 1, decreasing in thermal intensity as the range extends outward from the ship within Zone 2, to a less tangible and less likely threat from an unignited vapor cloud in Zone 3.

4.1.3 Expanded Zones of Concern

The Sandia Report was based on LNG vessels of approximately 148,000 cubic meter in capacity which was the largest size LNG vessel at the time. Since the publication of the Sandia Report, much larger LNG vessels have been designed and are

[27] U.S. Coast Guard Navigation and Vessel Inspection Circular No. 05-05, "Guidance on

currently being built. In 2007, the Sandia was contracted to conduct a follow-on LNG study to address the larger size LNG vessels. In particular, the new Report is intended to define the Zones of Concern for LNG vessels of the new Q-Max class of approximately 266,000 cubic meters. Accordingly, an attempt was made in this report to anticipate the results of the new Sandia Report and subsequent Coast Guard guidance in an effort to expedite future decision making for the new Q-Max LNG ships.

As mentioned in Section 3.5 above, a representative at Sandia, Mr. Mike Hightower, was contacted and he provided information as to the results of the recent Sandia analysis. The draft report is complete and going through agency review at the time of this writing. The new Sandia analysis reportedly found that the new ship/cargo tank sizes resulted in less than a ten percent increase in the size of the potential liquid pool/fire danger zones over the 2004 study results. Once the new Sandia Report is approved, it is expected that the Coast Guard will revise its guidance in NVIC 05-05 where the current zones of concern are published to reflect the changes in the LNG industry/ship sizes. It can be anticipated that either the current Zones of Concern will be changed or a new set of Zones of Concern will be issued for the new classes of LNG ships. Accordingly, this report includes a 12 percent increase in the zone ranges. If the revised Coast Guard guidance is within the Zone sizes used in this report, COTP Portland may choose to approve the use of the larger ships by Oregon LNG based on information in this WSA.

The risk assessment was completed based on the expanded zones listed in Table 4.1 below.

Assessing the Suitability of a Waterway for Liquefied Natural Gas (LNG) Marine Traffic"

Table 4-1
Sandia Zones of Concern & Expanded Zones of Concern

	Existing Sandia Zones	Expanded Zones
Zone 1	500 meters	560 meters
Zone 2	1,600 meters	1,800 meters
Zone 3	3,500 meters	4,000 meters

4.2 STAKEHOLDER INVOLVEMENT

Many stakeholders were contacted as information was gathered to develop the port characterization phase of this report. The Columbia River Bar Pilots were consulted frequently for advice on developing the track line, for information on maritime traffic throughout the route, and for information on vessel schedules management practices and concerns over weather and Bar conditions. Meetings were held with harbor masters in Warrenton and Ilwaco, with fire department and police department representatives in Warrenton, Astoria, and Ilwaco. A meeting was held in March 2007 with commercial fishermen operating out of Warrenton to hear their concerns. As mentioned earlier in this report, conversations were held with marine enforcement personnel with the Oregon State Police and Washington Fish and Wildlife to gather information concerning fishing activities in the area. Data was collected from Oregon and Washington Departments of Fish and Wildlife. Conversations were held with the Columbia River Steamship Operators Association to ascertain concerns of shippers in the Lower Columbia River. Similarly, several tug companies were contacted to get an estimate of the amount of tug and barge traffic occurs in the area around the proposed facility.

Oregon LNG did a great deal of outreach before entering the FERC pre-filing process. Meetings were held with officials from the cities of Warrenton and Astoria to introduce them to the proposal and garner support. Public hearings were held in June 2007 in Warrenton, Woodburn, and Forest Grove after pre-filing to provide information

to the public concerning the proposal and gather information about concerns or objections. Extensive work was done with the City of Warrenton to obtain zoning approval for the facility site.

To develop the "change analysis" and "what if" scenarios for the risk assessment portion of this report, a Risk Assessment Workshop was organized and held in the Warrenton Community Center on October 31, 2007. The invitation list was developed in close coordination with the U.S. Coast Guard. The attendance list is attached in Appendix G.

4.3 CHANGE ANALYSIS

As the name implies, Change Analysis looks systematically at what changes may occur if this new facility is established. The proposed LNG facility and the LNG ships servicing it will be operating in an established navigable waterway and will bring a change to that waterway. The Change Analysis is a qualitative tool to identify and examine the possible effects of these changes, determine if mitigation measures should be implemented so that the maritime transportation system (MTS) can safely handle or absorb these changes.

Using the Change Analysis decision tools provided, Halcrow representatives worked with key Federal, State and local stakeholders from Oregon and Washington in a Risk Assessment Workshop to develop the following:

- A clear list of how the changed situation is different from existing conditions and operations – "Difference from Normal Port Activities"

- A list of the possible effects on the waterway of these new "differences" created by this new enterprise – "Possible Effects"

- Review of what is already in place to control or manage risk – "Existing Prevention Policies/Practices/Requirements"

- Recommended new practices, procedures, risk management strategies – "Recommended Additional Requirements"

This section will summarize the findings of the Change Analysis attached in Appendix D. Six "Differences from Normal Port Activity" were identified and are discussed below:

- Additional ships transiting the Lower Columbia River
- Larger ships/New class of ships entering the river
- Introduction of LNG cargo by ship
- New LNG Facility in port
- Cargo transfer activity at facility
- Increased tug activity

4.3.1 Additional Ships Transiting the Lower Columbia River

The projected increase in the number of ships entering the Columbia River, 2 to 3 per week, if the Oregon LNG Terminal is constructed, was discussed and deemed manageable. A number of possible effects were raised and discussed concerning the additional number of ships, including potential delays to commercial ship traffic in the river, additional disruption to the commercial and recreational fishing, and the increased chance of accidents.

As discussed in Section 2.4 above, "Large Commercial Traffic on the Lower Columbia River", the Columbia River has handled a greater number of vessel transits in the past. A review of historical shipping data provided by the Columbia River Bar Pilots (and corroborated by two different studies) revealed that the Columbia River Bar monthly traffic has dropped since the 1990's with ship traffic dropping from 351 transits per month in 1992 to 288 per month in 2006 (Table 2-2). These numbers are transits, not the number of ships. Each ship will generally make an inbound transit and an outbound transit. It is essentially the number of times piloted vessels would pass the facility. These numbers break down further to about 12 per day in 1992 and 10 per day

in 2006, which means an average day in 2006 had 5 up bound ships and 5 down bound. Adding to that the 2-3 tug transits estimated per day past the facility in Section 2.6 of this report (use 1 transit each way) and the average upbound transits for vessels using the shipping channel is approximately 6 per day up bound and 6 down bound. The additional 2-3 ship visits per week proposed for the Oregon LNG Terminal will add less than one transit, either upbound or downbound, per day on average. While clearly the Columbia River Bar Pilot's Association will need to continue to closely monitor and manage ship traffic on the River, this incremental increase should not impact the flow of shipping. The pilots have been managing vessel traffic for years and Capt Gary Lewin, President of the Columbia River Bar Pilots, stated that the incremental increase would not pose a problem for safe navigation. Other issues concerning the nature of the cargo and security concerns add complications that will be discussed in a following section. The introduction of AIS (Automatic Identification System) and the electronic tracking systems used now by the pilots and the Regional Maritime Security Coalition has helped better manage the shipping traffic and these systems should help ensure that LNG ship traffic does not burden the waterway for commercial traffic.

One additional issue noted during the Risk Assessment Workshop discussions that relates to ship scheduling was related to the size of the LNG ships. This WSA is using the expanded Zones of Concern for the Q-Max size ships. If the facility is approved and they are permitted to operate using the Q-Max ships, the number of ship visits will be reduced dramatically, almost by half. If the Q-Max LNG ships are approved, the number of visits to the terminal may be 1-2 per week versus 2-3. That will further reduce the chance of any disruption to existing shipping in the Columbia River.

While the increase in number of ships does mathematically increase the probability of marine accidents, such as groundings, collisions, and allisions with the dock when mooring, it was noted that these ships are highly regulated both in construction standards, required safety equipment, navigation system, and in training/qualification requirements for crew members. It was not considered a major concern. The Bar pilots did point out that they consider it prudent to install a new fixed visual aid to navigation, such as a terrestrial range, to mark the transit down

Desdemona Shoal Channel to reduce the chance of any navigational errors. *(Recommendation 7.3 (B)(19))*

4.3.2 Larger Ships/New Class of Ships

The Oregon LNG Terminal proposal is requesting that Q-MAX Class LNG Ships be allowed to use the new facility. These ships will be some of the largest, if not the largest, that have entered the River in terms of length and breadth. There are other ships that enter the river with greater drafts.

A vessel transit and vessel docking simulation study entitled the, "Oregon LNG Simulation Report"[28] (Appendix T) was conducted by the Columbia River Bar Pilots at the Pacific Maritime Institute (PMI) in Seattle, WA. The intent of the Simulation Study was to determine the feasibility of bringing the larger, 266,000 cubic meter, vessels up to the proposed Terminal site by conducting simulation runs between the Columbia River Sea Buoy and the proposed Oregon LNG Terminal. A total of forty simulation runs were completed during the five day Study which included; Bar crossings inbound and outbound between Buoy 2 and Buoy 14, River transits inbound and outbound, docking and undocking maneuvers, and emergency simulations.

The "Conclusions and Recommendations" of the Simulation Study recommended that the larger LNG vessels are suitable for the Columbia River transit and mooring at the proposed Oregon LNG terminal with the following restrictions:

(A) BAR CROSSINGS INBOUND

"Simulator hydrodynamic models became difficult to handle going over the bar, with winds in excess of twenty-five (25) knots and waves up to sixteen (16) feet. This indicated the upper operational range. Please note that the combination of the specific vessel load, the presence of strong winds and currents, and multiple swell trains may

[28] "Oregon LNG Simulation Report." Revised 01/03/08

substantially affect the upper limit. It was assumed that the tugs would not be able to make-up to a vessel in these conditions." *(Recommendation 7.3 (B)(2))*

(B) BAR CROSSINGS OUTBOUND

"Simulator hydrodynamic models became very difficult to control, with winds in excess of twenty-five (25) knots and seas up to twenty (20) feet. This is an indication of the upper operational range. Please note that the combination of the specific vessel load, strong winds and currents, and multiple swell trains may substantially affect the upper limit. It was assumed that the tugs would not be able to make-up to a vessel in these conditions. Also note that an ebb of 0.4 to 1.8 knots and flood of 0.7 to 3.0 knots between Buoy 4 and Buoy 14 were used during the bar crossing simulations." *(Recommendation 7.3 (E)(4))*

(C) RIVER TRANSITS INBOUND

"The simulation indicated that the ship models should tether one (1) tug through the ship's center lead aft, as soon as conditions permit, after Buoy 6 or after crossing the Bar in rough conditions (provided slowing down for the tug does not jeopardize the execution of a safe turn around Buoy 10 and Buoy 14). A second (2nd) tug should be standing by to escort the vessel, as soon as conditions permit, after crossing the Bar. The tethered tug was effective in assisting the vessel through the turns and slowing the vessel down on approach to the terminal. The Pilots were able to handle the ship models, without incident. Simulation exercises included various runs with winds up to twenty-five (25) knots and ebb or flood currents ranging from 1.2 and 2.7 knots between Buoy 10 and Tansy Point." *(Recommendation 7.3 (B)(6))*

(D) RIVER TRANSIT OUTBOUND

"The simulation for outbound transits indicated that the ship models should tether one (1) tug through the ship's center lead aft during the transit from the terminal to Buoy 10, and then escort the ship to Buoy 6, conditions permitting. Also, a second (2nd) tug should escort the vessel from the Terminal to Buoy 10. *(Recommendation 7.3(E)(3))*. The Pilots were able to handle the models, without incident, using the above arrangements. Simulation exercises included various runs with winds up to twenty-five

(25) knots and ebb or flood currents ranging from 1.2 and 2.7 knots between Buoy 10 and Tansy Point. The tethered tug was effective in controlling the ship model during the simulated casualties." *(Recommendation 7.3 (E)(4))*

(E) DOCKING

"The Pilots felt that they should always have the option of docking port or starboard side, depending on the conditions. The Pilots decided that the "starboard side to" would likely be the most common maneuver. Starboard side dockings kept the vessel heading into the simulated ebb currents. Additionally, the starboard side docking kept the relative angle of the flood current to less than ten (10) degrees off the stern. *(Recommendation 7.3 (C)(5)).* The steady wind limitation for docking these vessels was shown to be 25 knots with ebb currents in the basin up to 1.6 knots and flood currents up to 1.4 knots. *(Recommendation 7.3 (C)(1))*. The current model was based on 90 minutes either side of Slack High Water during a moderate river flow day. In these conditions all three tugs were required to maneuver the vessel alongside. Tugs were operated at full speed on several occasions.

In winds of 10 knots the current limitations could be increased to 2.5 to 3 knots of flood or ebb in the basin and at the terminal."

(F) UNDOCKING MANEUVERS

"The steady wind limitations for undocking these vessels were shown to be 25 knots. *(Recommendation 7.3 (E)(1))*. Winds with a northerly component with a flood current generate the most difficult undocking conditions, because the wind and current are holding the vessel alongside the terminal. Again, with ebb currents in the basin up to 1.6 knots and flood currents up to 1.4 knots the vessels could be maneuvered off the dock and into the channel using all three tugs.

In winds with a northerly component of 10 knots or wind with a southerly component the current limitations could be increased to 2.5 to 3 knots of flood or ebb in the basin and at the terminal."

(G) LNG SHIP STEERING CASUALTIES

"The Pilots were able to control the ship model after a simulated "hard over" rudder failure when the vessel's speed was less than eight (8) knots and had a tethered escort tug through the center lead aft and a second (2nd) tug assisting, as directed. The ability to do so in real-world conditions will depend on the type of tug, tug Master/Pilot skills, and environmental conditions." *(Recommendation 7.3 (B)(4))*

(H) OTHER VESSEL CASUALTIES

"To minimize the risk of a transiting vessel with a casualty colliding with an LNG ship docked at the terminal, one tug should escort the transiting vessel between Buoy 27 and 31 and a second tug should be on instant standby in the terminal basin. Under most circumstances the tugs will not be required to make up to the vessel, but in the case of a vessel that is proving difficult to handle, the pilot may require the tug to make up to that vessel." *(Recommendation 7.3 (C)(10))*

(I) IMPORTANT NOTES

- "Although the LNG models proved to be controllable in these wind and current conditions, the pilots stated that during the first arrival and departure transits, environmental conditions less than those used for the simulation would be preferable.

- While maneuvering, the pilots took full advantage of the twin propellers, rudders and a bow thruster available on the 216,000m3 and 266,000m3 models. Maneuvering these larger ships without the advantages of twin propellers and bow thruster will be more challenging. Naturally, the environmental limits of operation may have to be lowered in this case."

(J) MEETING OTHER VESSELS

"The general consensus among the pilots is that they should not meet other vessels while transiting between Buoy 8 and the Terminal. During river transits with winds of 25 knots the swept path of these vessels took up much of the available channel." *(Recommendation 7.3.2 (B)(5))*

(K) NAVIGATIONAL AIDS

"A method other than buoys should be employed to indicate the extent of the dredged basin. Buoys were not recommended because they are prone to damage by transiting vessels." *(Recommendation 7.3.2 (C)(3))*

(L) DREDGE TURNING BASIN

"Pilots suggest that the basin dredging be extended from the proposed SW corner to the corner of the river channel in position latitude 46 11.31N, Longitude 123 54.54W…"[29]*(Recommendation 7.3.2 (C)(2))*

4.3.2.1 Weather conditions at the dock were discussed at length during the Risk Assessment Workshop. Mr. Jeff Ely, of CH2M Hill, the company responsible for designing the pier, stated that the dock and ship mooring system is designed for the ship to remain safely moored to the dock with continuous winds of 40 knots (46 mph). Members of the Workshop stated that wind speeds have been higher than that, but possibly not on a continuous basis. As discussed in Section 3.1.2, subsequent to the meeting, the berthing arrangement was further optimized such that the final calculated mooring capacity is at least 56 knots sustained wind speed. Sustained wind speed denotes duration of 10 minutes with an average velocity of 56 knots measured at the terminal. 50 knots is the expected maximum wind speeds averaged over 10 minutes in a 100 year return period. Three second gusts of up to 81 mph are expected in the same 100 year return period. [30]

4.3.2.2 It is recommended that at least two tugs be on immediate standby whenever an LNG ship is moored at the Terminal and that those tugs could be used to either assist the ship getting underway or actively hold the ship to the

[29] "CH2M Hill/Oregon LNG Simulation Report." Revised 01/03/08. Pages 5-8.

pier if the wind speed increases to above 56 knots. *(Recommendation 7.3.2 (C)(8)).* It is expected that major winter storms that are capable of generating winds higher than the 56 knots continuous winds should be predictable and the ships should depart port prior to major storms arriving. Therefore, policies should also be developed to address what predictive actions should be taken by an LNG vessel if weather conditions are worsening, either to depart port if moored or to delay entry into port if it is expected that they will not be able to remain moored long enough to offload. *(Recommendation 7.3.2 (C)(14))*

4.3.2.3 An interest was expressed by the Bar Pilots in obtaining a "dynamic under keel clearance system" that is in use elsewhere in the world to accurately measure the depth that large ships dip in heavy swells as a means to ensure safely crossing the Bar. The system also maximizes the ability for ships to transit the Bar by reducing the guess work concerning a ship's actions in heavy weather. Dynamic under keel clearance is a method of combining squat, heel and wave-induced motion calculations into an overall under keel clearance. It can be used to develop under keel clearance guidelines for assessing the safety of specific ship transits. *(Recommendation 7.3.2 (B)(3))*

4.3.2.4 These LNG ships, regardless of the size eventually approved, will be new to the pilots. It was recommended that the Columbia River Bar Pilots not only "test" the proposed new vessels on a simulator, but receive training for the types of ships arriving. *(Recommendation 7.3.2 (B)(1))*

4.3.3 Introduction of LNG Cargo into the River by Ship

The introduction of LNG into the Columbia River is the main issue that creates the need for security measures that in turn complicates ship traffic management. The shipping channel in the Columbia River is relatively close to shore, which causes the Zones of Concern defined in NVIC 05-05, and further modified in this report, to overlap

[30] "Oregon LNG Terminal and Pipeline Project Wind/Current Data Analysis Alignment Alternatives Study." Table 4. Page 6. Appendix "U"

land as soon as the ship approaches/enters the Bar and throughout the transit to the dock.

As discussed in Section 3.5, and as can be viewed in the nautical charts in Appendix A and the Google pictures in Appendices B and C, the Zones of Concern begin overlapping land as the inbound ship approaches Buoy 4 in the Entrance Channel. It was recognized that security measures to mitigate risk will be necessary. Security zones will need to be established around the LNG ships and enforced with security escort boats beginning in the Columbia River Bar or as soon as possible thereafter depending on the weather. It was also recognized that while the security escorts are effective against small boat threats, vessel management practices will also need to be implemented to prevent these ships from meeting other ships in the Desdemona Channel as a means to mitigate the threat of the LNG ships being rammed by another ship. Shore side patrols will be necessary in advance of the ship arrival to ensure no suspicious shore side activity is occurring that could result in a stand off weapon attack.

The size of the security zone is the most controversial issue of all the mitigation strategies. A 500 yard safety/security zone would impact all traffic, commercial and recreational, along the Desdemona Shoal Channel as the channel is only 200 yards wide (600 feet). A strictly enforced 500 yard safety/security zone around an inbound vessel would extend west almost to the shore line at Clatsop Spit, the point of land at Hammond Marina, and Tansy Point. To the east, the security zone would extend over 400 yards outside the maintained ship channel towards the shoal waters of Desdemona Sands. It effectively forces one-way traffic for all vessels constrained to the channel by draft and would force smaller vessels well away from the channel to waters that are closer to shoal water and not as well marked. In some areas, such as Tansy Pt, the security zone extends all the way to shore and would cut off all traffic trying to transit on that side of the channel until the ship passed. Additionally, boats that are fishing near the edges of the channel such as crabbers or those fishing for sturgeon would have to move until the ship passed.

Therefore it is proposed that consideration be given to a flexible security zone that permits entry closer than 500 yards with restrictions based on the speed of the

small boat approaching the LNG vessel or at the discretion of the patrol commander. The security zone currently in effect for cruise ships navigating on the Columbia River, 33 CFR 165.1318, allows this flexibility. It establishes the zone at 500 yards, but allows entry closer based on vessel speed and the discretion of the Coast Guard on enforcement. In addition, COTP Portland published a WSR for the Bradwood LNG facility proposal requiring a 500 yard zone with the stated expectation that the patrol commander would be reasonable, permitting boaters within the zone so long as they are moving at bare steerageway or they remain anchored or stopped while fishing. This approach minimizes the impact on other boaters during normal threat conditions. If the threat level increases, the workshop recognized that the security zone would have to be more rigorously enforced.

The need for a fixed security zone around the ship when moored was also discussed. The distance proposed was 200 yards which aligns with the proposed zone in the Bradwood Landing WSR. [31] A 200 yard fixed security zone would not interfere with the Skipanon Waterway. The issue of installing an anti-boat barrier was discussed. There were pros and cons. It was recognized that a barrier would enhance dockside security from a small boat threat, but it was left for the Oregon LNG representative to look into the feasibility of installation in that mooring configuration. A barrier may reduce the number of security boats needed when the ship is moored.

Also discussed was the additional safety practice of having two of the facility tugs meet the arriving LNG vessels in the Bar area, between buoys 8 and 10, weather permitting, to escort the ship to the dock. One of the tugs would be tethered in order to provide immediate assistance if there is a propulsion or steering casualty or other issues that would require tug assistance. The Simulation Report, discussed in Section 4.3.2 above, supports this recommendation. Specifically this Study recommends that, "The simulation indicated that the ship's models should tether one (1) tug through the ship's center lead aft, as soon as conditions permit, after buoy 6 or after crossing the Bar in rough conditions. (provided slowing down for the tug does not jeopardize the execution of a safe turn around Boy 10 and Buoy 14). A second (2nd) tug should be

standing by to escort the vessel, as soon as conditions permit, after crossing the Bar."[32] *(Recommendation 7.3(B)(6))*

Additionally, there was discussion concerning the lack of experience of the local Warrenton fire fighters on shipboard fires and the fact that Warrenton is not currently a member of the Maritime Fire & Safety Association (MFSA) which is an organization that pools resources for maritime incidents. It was also pointed out that the hospital in Astoria was not a burn center. They will screen patients and then likely send them to Portland via air ambulance. That also brought up the topic of potentially needing an air ambulance on call. These issues were noted, but put on hold as issues more appropriately dealt with when developing the Emergency Response Plan.

4.3.4 New LNG Facility in Port

The operation of the proposed facility in an area of the Columbia River that currently has no deep water port was expected to bring some changes. The new shipping and tug activity with the requisite security zones may impede some access by recreational and commercial vessels in and out of the Skipanon Waterway when the ships are maneuvering to or from the dock. Similarly, vessels coming out of Youngs Bay heading down river, or other down bound vessel traffic in the river may be delayed while the ship is maneuvering. However, the few times a week that occurs was considered minimal.

The primary focus of the Risk Assessment Work Group discussions in this area was the need to establish a fixed security zone around the facility when a LNG ship is moored. There will be a requirement for a fixed security zone enforced by security boats and potentially an anti-boat barrier. Using the Bradwood WSR as a reference, it was proposed that the fixed zone be 200 yards. *(Recommendation 7.3.2 (C)(6)).* If that range is adopted, there would be no interference with vessel traffic in and out of the

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[31] Waterway Suitability Report for Bradwood Landing LNG dated February 28, 2007. Page 2 of 6.

[32] "CH2M Hill/Oregon LNG Simulation Report." Revised 01/03/08. Page 5.

Skipanon or Youngs Bay while the ships are moored. Oregon LNG will look into the engineering feasibility of installing an anti-boat barrier. It was recognized that the location, river currents, and lay-out of the dock may make the barrier impractical. In addition, there was also some concern expressed that the barrier would slow emergency response time to get the ships underway if an emergency arises.

The location of the facility raised two other issues with the Risk Assessment participants; (1) The possible impact of surge from a passing vessel on a moored LNG vessel, and (2) The possibility of another deep draft vessel accidentally or intentionally alliding with a moored LNG vessel.

With regard to the possibility of a passing deep draft vessel causing a wake of such size that it could impact the moored ship or the cargo transfer gear, a “Mooring and Berthing Analysis Report”, (Appendix U), was developed by CH2M Hill for Oregon LNG. It is well known that a vessel passing parallel to a moored vessel can impart significant hydrodynamic forces on the moored vessel resulting in increased mooring line loads. In fact, a review of existing data by the author of the Report found more than 50 "breakaway" failures in the US during 1991 - 2001. The Naval Facilities Engineering Service Center has produced a computer program PASS-MOOR that estimates the forces imparted to a moored vessel by a passing vessel. This program was used to estimate passing vessel effects at the facility. The Study simulated a moored 266,000 cubic meter vessel being passed by another 266,000 cubic meter LNG vessel at 12 knots. The Report finds that, "Due to the relatively large distances between the moored vessel and passing vessel, as well as the adequate under-keel clearance at the berth, the passing vessel effects are small, at most increasing the maximum mooring-line tension by 9%." [33] The Report took the analysis one step further and determined that, "... for wind speeds of 60 knots or less, the combination of wind, current and passing vessel will result in mooring-line tensions that are within the allowable stress limits." [34]

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[33] “Mooring and Berthing Analysis, Oregon LNG Terminal.” Prepared by CH2MHill. January 2008. Page 2-7.

[34] IBID. Page 2-7.

Captain Gary Lewin of the Bar Pilots Association stated during the Risk Assessment Workshop, which was held prior to the completion of the "Surge Study", that the Pilots may have to slow large commercial vessels when they pass a moored LNG vessel. It is recommended that the Coast Guard COTP work with the Bar Pilots to evaluate the need for a vessel management policy restricting large vessels (over 50,000 GT) from transiting past the Oregon LNG terminal at over 10 knots whenever an LNG vessel is moored at the Terminal. *(Recommendation 7.3.2 (C)(9))*

The second concern addressed the possibility that another deep draft vessel could accidentally or intentionally allide with a moored LNG vessel. The participants discussed the idea of having one or more of the Terminal's tugs escort all large transiting vessels past any moored LNG vessel. This idea was supported by the CH2MHill Oregon LNG Simulation Study which recommended that; "To minimize the risk of a transiting vessel with a casualty colliding with an LNG ship docked at the terminal, one tug should escort the transiting vessel between buoy 27 and 31 and a second tug should be on instant standby in the terminal basin."[35] Therefore, it is recommended that policy or guidelines be developed requiring at least one the Oregon LNG Terminal tugs to escort all up bound and down bound ships of over 50,000 GT between buoys 27 and 31. A second tug shall be in immediate standby in the terminal basin. *(Recommendation 7.3.2 (C)(10)).* The scenario of another vessel being intentionally navigated into a moored LNG vessel is addressed in more detail in Section 4.5.

Activity within the area will increase as a result of both the construction of the facility, the dredging required, and the tug/security boat activity that will be necessary for operation of the terminal. It is not anticipated that any of it will significantly impede normal waterway use, specifically vessel traffic in the ship channel, the Skipanon Waterway, or Youngs Bay.

[35] "Oregon LNG Simulation Report" dated 01/03/08. Page 7.

4.3.5 Cargo Transfer Activity at Facility

Cargo transfer operations create a potential for accidents/connection leaks or breaks due to a variety of reasons ranging from human error, surge from passing ships, to weather. There are many regulations requiring safety equipment, gas monitors, etc. to address equipment failure at an LNG facility, which is overseen by FERC and the Coast Guard. It is expected that Coast Guard personnel will be on scene periodically to observe cargo transfers to ensure equipment operates properly and all safety procedures are followed.

To reduce the risk of high winds causing an accident with cargo transfer connections, policy or guidance should be developed which establish wind speed/direction limits at which point cargo transfer operations should be halted. The "Chesapeake Bay Liquefied Natural Gas (LNG) Operations Plan" requires transfer operations to be halted, "… if the sustained wind speed is greater than 30 knots." [36] As discussed in Section 3.1.2, the proposed facility's mooring rating is 56 knots so Baltimore's 30 knot criteria works with regard to the terminal's mooring rating. *(Recommendation 7.3.2 (D)(2)).* The cargo transferring gear including the unloading arms must be designed to withstand the wind speed limits imposed by the Coast Guard. Each arm would be fitted with powered emergency release coupling (PERC) valves to protect the arm and avoid spillage of its liquid contents.

4.3.6 Increased Tug Activity

As mentioned in earlier sections of this Change Analysis, tugs will meet and escort inbound LNG Vessels from the Bar to the dock. The Oregon LNG Simulation Report" dated 01/03/08 indicates that three tugs were required to maneuver the vessel alongside the dock.[37] The Report also noted that, "Tugs were operated at full speed on

[36] "The Chesapeake Bay Liquefied Natural Gas (LNG) Operations Plan, Change 1, March 2006." Page 7.

[37] Oregon LNG Simulation Report dated 01/03/08. Page 6 of 109.

several occasions."[38] Therefore, it is recommended that 4 tugs be available for docking the largest LNG vessels. *(Recommendation 7.3.2(C)(4)).* In addition, it is expected that there will be a requirement for tugs to be on scene in immediate standby whenever a ship is at the dock in order to assist the ship if the winds increase as discussed in the earlier section or to get underway in an emergency.

In addition, the potential for an accidental ramming of a moored LNG ship was discussed if another ship passing the facility has a steering or propulsion failure. In response to that scenario, it was recommended that one of the tugs on scene get underway and escort any large ships (>50,000 GT) passing the facility to be available to assist if there is a systems failure. *(Recommendation 7.3.2 (C)(10)).* Section 4.3.4 above also addressed the recommendation of having a tug escort large vessels passing the proposed LNG Terminal while a vessel is moored at the facility.

The Risk Assessment Work Shop participants did not believe that the additional tug traffic, including the tugs escorting the LNG ships and possibly tugs escorting other deep draft vessels transiting past a moored LNG vessel would have a significant impact on other activities on the River.

4.4 "WHAT-IF" SAFETY/ACCIDENTAL RISK ASSESSMENT

Section 4.1, Table 12, of the Sandia Report identified the following accidental breach scenarios:

- Collision at Low Speed
- Collision at High Speed
- Grounding

This WSA looked at four other scenarios that could possibly result in a release of cargo:

- Allision (ramming fixed objects such as a bridge or pier)

[38] CH2MHill/Oregon LNG Simulation Report dated 01/03/08. Page 6 of 109.

- Cargo Handling Mishaps
- Ship Breaks Mooring from Dock
- Aircraft crash

The safety "What-If" assessment looks at each scenario along the entire transit route and at the dock to identify potential areas of concern. It then determines the probability of each scenario happening, the potential consequences, and derives a Risk Score. As mentioned in Section 4.1 of this report, accepted risk based decision making (RBDM) practices calculate risk as follows:

Risk = Probability x Consequence

The following sections explain how we determined Probability and Consequence values and what assumptions were necessary.

4.4.1 Accidental Probability Determination

The U.S. Coast Guard "Risk Based Decision Making Guidelines for Maritime Security" publication describes "probability" for safety assessments as a determination of frequency of that type of event occurring. In other words, a historical track record is a good measure of the likelihood, or probability, of an accidental incident occurring.

A worldwide review of the safety record of LNG shipping is impressive. "During the past 40 years, more than 80,000 LNG carrier voyages have taken place, covering more than 100 million miles, without major accidents or safety problems, either in port or on the high seas. Over the life of the industry, eight marine incidents worldwide have resulted in LNG spills, with some damage; but no cargo fires have occurred. Seven incidents have been reported with ship structural damage, two from groundings; but no spills were recorded. No LNG shipboard fatalities from spills have occurred."[39]

While a broad historical review provides a testament to the structural integrity/reliability of the ships and the training of the crews, it does not specifically

reflect the likelihood of a future accident occurring in the Lower Columbia River. The most appropriate historical records were deemed to be the safety records of the Columbia River Bar Pilots since they are the professionals that would be piloting the ships across the Columbia River Bar and up river to the proposed terminal site.

Table 4-2 below provides summary data of reportable marine casualties over the past ten years involving vessels that had a Columbia River Bar Pilot embarked. All LNG ships would be required to have a Bar Pilot embarked.

[39] Sandia National Laboratories (SNL). "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water". P. 28.

Table 4-2
Marine Casualties (1997 – 2007)[40]

Type of Casualty	Number
1. Groundings (piloted vessels outside river mouth)	0
2. Groundings (piloted vessels inside river entrance jetties)	2
3. Collisions at Low Speed (with vessels of less than 50,000 GT)	0
4. Collisions at Low Speed (with vessels over 50,000 GT)	0
5. Collisions at High Speed (> 7 kts) (with vessels of less than 50,000 GT)	1
6. Collisions at High Speed (with vessels over 50,000 GT)	0
7. Allisions with docks/piers resulting in a reportable marine casualty	0

Refinement of accident data reveals:

- Both groundings listed in Table 4-2 occurred in the vicinity of Buoy 14. Neither incident resulted in significant hull damage. One of the groundings occurred when the pilot was maneuvering to avoid a small boat. The second grounding occurred due to a system failure (steering or propulsion).

- The high speed collision occurred in the vicinity of Tansy Point turn in low visibility between a ship with a pilot aboard and the Coast Guard Cutter COWSLIP.

- No collisions occurred involving two vessels piloted by Columbia River Bar Pilots.[41] This is significant because the Sandia Report determined that

[40] Safety data provided by Columbia River Bar Pilots, CAPT Gary Lewin

collisions with enough energy to penetrate the double hull of an LNG tanker would require another large ship, over 50,000GT, unless a smaller vessel had an unusually sharp bow. Pilotage is compulsory for U.S. vessels sailing under registry and all foreign flag vessels, (with exception of recreational or fishing vessels not more than 100 feet in length or 250 gross tons international), which would include ships over 50,000GT.[42]

Table 4-3 provides the scoring guidelines used in this Assessment based on the 10 years of reportable incidents identified in Table 4-2.

Table 4-3
Accidental Probability Scoring Guidelines

Incidents (10 year period)	Risk	Score
0 - 1	Low	1
2 – 3	Medium	2
4+	High	3

Due to the relative proximity of the Astoria Regional Airport to the proposed LNG Terminal, this report included a scenario for a light aircraft to accidentally crash onto a moored LNG ship. Since this would be a new facility where there has been no previous ship traffic, an assessment had to be made based on best available information and expert opinion. In an interview with Mr. Ron Larsen, Director of Operations for the Astoria airport, he recounted four aircraft "crashes" at the Astoria Regional Airport in the past 16 years. Two incidents occurred on attempted take-offs and two on landings. All four were on or near the runways. He could not recall any incidents of aircraft operating

[41] Ibid

[42] U.S. Coast Pilot 7, 39th Ed 2007, Pg 441

around the Astoria-Warrenton area crashing over a mile from the airport and he considered the probability for such an incident to occur as low. As evident by the incidents that have occurred at the airport, most incidents with light aircraft occur on take-off or landing. Light fixed-wing aircraft do not generally lose complete control when airborne, usually retaining some ability to steer and choose their landing site. While not always the case, it is fully expected that a small aircraft or helicopter experiencing an in-air emergency would avoid landing on a ship. Accordingly, the probability for such an incident was determined to be low.

Table 4-4
Scenario Probabilities (Combining Tables 4 -2 & 4-3)

Scenario	Probability
1. Groundings (piloted vessels outside river mouth)	Low (1)
2. Groundings (piloted vessels inside river entrance jetties)	Medium (2)
3. Collisions at Low Speed (with vessels of less than 50,000 GT)	Low (1)
4. Collisions at Low Speed (with vessels over 50,000 GT)	Low (1)
5. Collisions at High Speed (> 7 kts) (with vessels of less than 50,000 GT)	Low (1)
6. Collisions at High Speed (with vessels over 50,000 GT)	Low (1)
7. Allisions with docks/piers resulting in a reportable marine casualty	Low (1)
8. Aircraft Crash into LNG Vessel	Low (1)

4.4.2 Consequence Determination

The focus of the WSA is on the potential consequence resulting from a breach of the cargo tanks and a spill of the LNG cargo. If the ship has an incident that does not result in a breach of a cargo tank, it would be handled much the same as a marine casualty of other ships in the waterway, albeit with much more emphasis on security. There may be, and probably will be, consequences of the marine casualty that will need to be resolved, but not considered in the context of this WSA.

NVIC 05-05 directed the use of three Zones of Concern to be used when determining consequence from an LNG spill over water. As discussed in Section 3.5 above, we employed larger "expanded" Zones of Concern to address the new larger LNG vessels expected to call at the Oregon LNG Terminal in order to analyze what might be considered to be the worst case scenarios.

The NVIC 05-05 focus for consequence is the threat to public safety from an LNG cargo spill. NVIC 05-05 defines population densities that are to be overlaid on the chart with the track line. The intent is to determine where, ". . . the three Zones of Concern intersect with population areas, critical infrastructure and key assets, critical waterways, and commercial, industrial, or environmentally sensitive areas in and adjacent to the transit waterways. This will identify those areas where an intentional release of LNG would have the most dire consequences"[43] To reflect the Zones of Concern overlap of land in relation to population densities and establish a numerical scoring criteria, Table 4-5 was created using the format provided in Table #7 of the U.S. Coast Guard NVIC 9-02.

In addition to the scores in Tables 4-4 and 4-5, two other scoring mechanisms were used in the worksheet tables found in Appendices E and F. In Appendix E, scenarios where the cargo tanks are not expected to be breached and the cargo released are assigned a Consequence Score of "N/A". In Appendix F, if the Zones of

[43] NVIC 05-05 Page 4

Concern do not overlap land, a Consequence Score of "0" was given in order to indicate the lesser consequence and a difference between an overlap over water versus land.

The "N/A" designator does not indicate that a marine accident or incident involving an LNG ship won't cause property damage or some environmental damage. It simply means that the threat to public safety as it relates to an LNG spill over water of the size modeled in the Sandia Report was not applicable, which is the primary focus of this WSA. As mentioned earlier in this section, there will probably be damages associated with a collision or grounding as would be the case with any marine accident involving a ship, but without a cargo tank breach and resulting spill, it would be on a lesser scale than the consequences being addressed in Table 4-5. They would be more in line with any other reportable marine incidents.

The "0" designator does not indicate that there is no consequence to people over water, but that the consequence involved in the marine environment is considered minimal compared to scenarios where the Zones of Concern overlap land. The ships will normally be transiting offshore at "sea speed" which is usually 15 knots or higher and will normally keep their distance from other vessels. As will be discussed further in Section 4.4.4, the mathematical models which were used in the Sandia Report to develop the range of the liquid pools were based on the ship moving slowly or stopped (less than 7kts). [44] The faster speed elongates any spill that might occur, reducing the amount of lateral spreading. In addition, boats/ships are mobile so the occupants of vessels in the area of an LNG ship experiencing a spill should be able to take avoidance actions. This rationale does not apply as the ships slow down and get within more restricted waters in the river where boating density is higher and in some cases less mobile if they are anchored or fishing with gear down. In general, the population for both water and land is reflected in the Zones of Concern consequences as the ship approaches the river mouth and gets within Zone 3 range of land. In the case of the busiest fishing seasons (June – Sept) including the "Buoy 10" season, it was determined necessary to include a specific entry in the risk worksheets noting the

[44] Phone conversation between Mr. David Ryan, HPA and Mr. Mike Hightower from Sandia National Laboratory - July 2007.

increased population density to Medium within the area between Buoys 10 and 14 due to the potential number of boats concentrated in that relatively small area. The ocean sport salmon season outside the river mouth was also considered, but not adopted since there is more room for the boats to spread out than in the confines of the river and the ship will be traveling at sea speed.

Table 4-5
Consequence Matrix

Population Density	High (3)	2	3	3
	Medium (2)	1	2	3
	Low (1)	1	1	1
		Low - 1 (Zone 3)	Medium – 2 (Zone 2)	High – 3 (Zone 1)
		Zones of Concern		

4.4.3 Assumptions for Safety Scenarios

For purposes of this WSA, certain assumptions were made with respect to the safety scenarios to be discussed. These assumptions include:

- The modeling set forth in the Sandia Report is accurate in regards to damage incurred by the LNG ships and spill results. Based on other studies and available literature, this assumption produces conservative results.

- Groundings will not occur while the ship is on the track line. Groundings will only occur if the ship veers or drifts off course significantly for some reason. Ships will stop when they reach positions where the charted depth is 30 feet. That allows for reasonable tidal height and some progress plowing through mud.

- Collisions would happen while the ship is proceeding in the ship channel following the track line.

- Accidents involving an LNG vessel in a “heel” condition would not result in a Sandia size LNG spill. In the Federal Register dated January 19, 2007 (Volume 72, Number 12)] the Coast Guard determined that LNG vessels carrying only “heel'' pose a minimal risk of an LNG spill. The definition of heel used in the FR was ”the minimum quantity of liquefied natural gas (LNG) retained in an LNG tankship after unloading at the LNG facility to maintain temperature, pressure, and/or prudent operations”. Therefore, the risk scenarios discussed below only address arriving (loaded) LNG vessels. Departing (unloaded) LNG vessels are not addressed unless for some reason the vessel is departing carrying more than the required “heel”.

4.4.4 Sensitivity

This WSA is premised on the mathematical modeling work set forth in the Sandia Report that established sensitivities within the study. The Zones of Concern published by the Coast Guard were based on the predicted LNG pool sizes and radiant heat energy levels that extend out from the expected fire. The “Zones” were established, combining both the safety and security scenarios as a means to establish very conservative parameters and simplify the review process. As will be discussed further below, the security scenarios created much larger pools/fires and vapor clouds than did the safety/accidental scenarios. Consequently, the established zones of concern are much larger than what actually was determined in the analysis for accidental scenarios.

The Sandia Report determined approximate hole size created in the cargo tanks of typical LNG ships for accidental incidents and intentional attacks. The sizes of holes created in cargo tanks projected from accidental mishaps were significantly smaller than those that could be created using intentional scenarios. Therefore, the zones associated with an accidental release scenario were actually much smaller, almost half of the size of intentional scenarios. On pages 74 and 75 of the Sandia Report, the sizes of the Zones of Concern for accidental breaches were described as Zone 1 extending out from the ship to 250 meters; Zone 2, extending from 250 meters to 750 meters, and;

Zone 3, extending beyond 750 meters. On page 77, the Sandia Report identifies that the outer limit of Zone 3 as 1,700 meters.

In reality, this had little effect on the results. The only accidental scenario predicted by the Sandia Report to cause a cargo breach is the "high speed collision." This scenario is essentially the same as the "large ship ramming" scenario under the security section, which created one of the smaller spill sizes under the security scenarios. The NVIC zone sizes were very conservative and based on worst case scenarios. Taken into consideration, actual modeling results and adding the 12 percent expansion, the accidental collision scenario and corresponding ramming scenario would create a spill that had a Zone 1 extending 280 meters or 307 yards. That would not overlap any land as portrayed in the tables using the standard zone sizes, including Tansy Point which is the nearest point of approach to land throughout the transit. Therefore, the findings in this assessment should be considered extremely conservative.

There are too many unknowns to determine personnel casualty numbers from a major LNG spill. The models contained in the Sandia Report only predict areas that may be hazardous based on heat levels and the possible presence of an unignited LNG vapor cloud due to proximity to the spill. However, it can be assumed that persons in the area will seek shelter if they feel an uncomfortable level of heat. When considering populations on land it is likely that shelter will be available in terms of buildings, walls, ditches, etc. or that people will run away if they start getting hot. The shelter may or may not be effective in protecting the person, depending on the proximity, but the fact that someone is "in a zone" does not necessarily equate to a casualty; rather, it indicates that there is the potential that a casualty may result. It is much more likely in Zone 1 than Zones 2 or 3 simply because of the heat level.

The modeling assumed an open water scenario and did not consider the effect of the land/water interface stopping the flow of the LNG pool. That may limit the extent of the radiant heat, such as the potential grounding scenario on the North Jetty. They recognized the need for site specific study but intended to present the worst case scenarios. Similarly, the models and Zones of Concern do not account for the possibility that structures such as piers may hinder the flow of the pool and/or provide a

shield against the impacts of thermal radiation which could be the case when the ship is moored. These are examples to show that the zones used to determine potential consequence are very conservative.

Another example of how conservative the Zones of Concern are involves the ship's speed. The modeling assumed that the ship would be approaching the port and mooring proceeding at less than 7 knots. A pool spread from a ship moving at a faster speed would experience more "elongation" in the liquid pool, which would in turn reduce the amount of lateral spreading (out to each side of the track line). In many places along the transit route it is expected that the ship will be exceeding this 7 knots, such as when transiting into the mouth of the river and along much of the Desdemona Shoal Channel. This discussion is not to argue to use different standards, only to highlight that the portrayal of the spill size and corresponding potential fire/heat danger is very conservative and can be considered when reviewing and making recommendations for mitigation measures.

NVIC 05-05 establishes the criteria for population densities to use for the WSA. The population criteria deals with fairly large numbers of people over a broad expanse of land (>1000/square mile and >9000/square mile). The guidelines are within sensitivity criteria of the census and the data from the 2000 Census was used in the chart displays. Because the data provided by the U. S. census was by square mile, the actual disposition of the people within the square mile may mean the portrayal of population within the zone is better or worse than represented on the charts. In cases where the zones overlapped populated land, further review was conducted to confirm the population density in that area. There were some areas where a small zone overlap along a beach area clearly did not have much of a population density and it was adjusted accordingly. Similarly, after discussions with the Risk Assessment Workshop group, it was decided to recognize the summer seasonal influx of tourists and consider Warrenton a Medium density for that period. The same seasonal consideration also applied to the Cape Disappointment and Fort Stevens state parks. These areas will be addressed later in the discussions of the specific scenarios.

4.4.5 Safety/Accidental 'What if' Scenarios

Copies of the Safety/Accidental 'What If' scenario worksheets are included as Appendix E and a score summary sheet is included in Appendix G. To conduct the 'What If' process, worksheets were prepared to review the entire transit from 12 nautical miles offshore to the dock applying the three principle scenarios listed in NVIC 05-05; groundings, low speed collisions, and high speed collisions, along the route and adding four more safety mishap scenarios; allision with a pier, cargo handling, the ship breaking loose from mooring, and light aircraft crash. In this part of the analysis, the scenarios were examined without consideration of risk mitigation measures in order to identify the high risk accident scenarios. Consideration of risk mitigation strategies will be addressed in Section 5, "Risk Management Strategies."

(A) GROUNDING

Since the ship will not go aground if it remains on track, it would need to veer from the intended track either through a navigation error or mechanical (propulsion/steering) problem. It was determined that a reasonable depth of water to use for a ship to come to rest with a draft of 38'-40' is at the 30' line, considering tide and swell action offshore and tide and the soft silt in the river.

The 30' depth line was traced on the paper charts and representative positions were selected along the track line where the ship could go aground closest to the shoreline with the greatest Zone of Concern overlap of land or where the ship could potentially reach rocks that may cause a breach. The Bar Pilots confirmed that the bottom is soft in the river and that the ship would settle on a sand bottom along the 30 foot line off the beaches of Fort Stevens State Park and Cape Disappointment. The only potential obstructions at the river mouth that might cause enough damage to create a cargo tank breach are the jetties.

Grounding statistics were split in Tables 4-2 & 4-3 to reflect the difference between open ocean steaming and river navigation. The open ocean is generally much more forgiving in terms of navigation errors and mechanical or electronic system failures simply because the distance offshore permits more time to make repairs or course adjustments. If there is a problem, the sea conditions offshore can be severe and

prevent attempts to assist a stricken vessel. The Bar Pilots cited incidents involving barges breaking loose from their tows and drifting ashore and a dead ship that similarly broke loose and drifted ashore, but no recent instances where a powered ship either inbound or outbound from the Columbia River under the control of a Bar pilot went aground outside of the river.

The probability score increases after the ships enter the more restricted waters of the Columbia River. There have been two reportable groundings in the last 10 years. Neither incident resulted in any significant hull damage, lending credence to the Sandia Report results that grounding should not normally cause a breach of cargo tanks in the LNG ships.

As a result, most of the areas along the track where the “What if” scenarios were examined resulted in a “N/A" Consequence Score since they were not expected to cause a breach in the cargo tanks of the LNG ships. The three locations identified along the track that had potential to damage the ships enough to cause a breach were all along the river mouth jetties.

Outside of the Columbia River mouth it is possible for a ship to go aground on the southern side of the rocks that form the south jetty. The scenario is not likely and received a Risk Score of “1”. To get to that location, the ship would have to travel approximately 5 nautical miles from the end of track leg one, or approximately 2.5 miles from track leg 2 as the ship passes Buoy 4.

Since a navigation error of that magnitude by a qualified Bar Pilot is not deemed likely, the most likely scenario would be loss of power on the ship for some reason that could not be repaired for hours resulting in the ship drifting onto the jetty. A steering failure may contribute to the ship being off course, but not to get that far from track. For the ship to get to that location would mean that tug assistance is not available, timely, or capable to assist in the existing conditions. It would also have to assume the anchors on the ship would not work or would not hold if dropped to anchor the ship. It is also not a certainty that even if a LNG ship did drift onto the jetty that it would in fact cause a breach in a cargo hold. Under mild sea conditions, it would be deemed unlikely. However, if the incident occurred during a storm or high sea conditions the ship would

take a beating on the rocks. Depending on how long and hard the pounding was sustained, damage to the cargo tanks could not be ruled out.

The nearest location on the southern side of the south jetty that the ship would get to land based on the 30 foot depth line was 1,300 yards (1,189 meters) off of the north head of Clatsop Spit, which is considered low population. The ship would not get closer than Zone 2 range of land. Considering the low probability and low Consequence Score from Table 4-5 of the incident happening, this scenario was assessed a Risk Score of "1".

Once the ship is in the mouth of the river, or entering the Columbia River Bar, there were two other locations examined on the jetties, one on the north side near the southwest tip of Cape Disappointment State Park and the other on the north side of the southern jetty.

On the southern jetty, again the ship would have to veer off course from track leg 2 and travel over a mile to the jetty. Again, a navigation error that places the ship in this location is very unlikely. The scenario again lends itself to a propulsion failure and/or possibly a steering casualty. It also assumes that tug assistance is not available and that the anchors will not function/hold. This location is further offshore than the previous jetty scenario, being approximately 4600 yards (4206 meters) from the north tip of Clatsop Spit and 4200 yards (3840m) from the southwest tip of Cape Disappointment State Park. This scenario received a Risk Score of "2".

The grounding scenario on the north jetty, marking the southern end of Cape Disappointment State Park, during the summer tourist season, created the highest Risk Scores for the grounding scenarios in general. Should the inbound LNG ship come to the end of track leg 3 and find that the rudders do not work when trying to turn right onto the next track leg, or a power failure also negatively impacts steering so that the ship continues towards the north jetty, the ship would still have to travel about a mile to reach the jetty. Again, the assumption has to be made that tug assist is not available or effective and that the anchors don't work or hold.

The incident would happen essentially along the shore/jetty of the state park Most of the year the population is low, but the summer months experience a large influx of visitors. Accordingly, the Risk Score was a "6".

(B) COLLISION/SLOW SPEED

The Sandia Report modeled the energy requirements to penetrate the inner hull and cargo tank of an LNG tanker caused by a collision of two vessels. The Report states that, "This would suggest the required velocity to cause a breach of an LNG cargo tank during a 90 deg collision with a large vessel to be about 6 – 7 knots. Collisions at shallower angles would need to be several knots higher in order to penetrate an LNG cargo tank."[45] A collision at any speed with smaller boats was determined unable to breach both hulls and a cargo tank A collision at low speed, which was described as less than 7kts with a large vessel, was determined to not to breach the hull of LNG. Therefore, a Consequence Score of "N/A" was applied to the "Low Speed Collision" scenario with a resulting Risk Score of "N/A".

(C) COLLISION/HIGH SPEED

As discussed above, the collision scenario capable of causing a breach in an LNG ship cargo tank involves another ship over 50,000 GT to hit the LNG in its side at a near 90 degree angle at over 7 knots. While this could happen when the ship is at sea, approaching the river mouth, the Probability Score from Table 4-3 is Low "1", with zero (0) incidents occurring offshore over the past 10 years. Once in the river system the ships and tug/barge combinations are following the deep water channels going either up bound or down bound. Accordingly, ship traffic can either "meet" or "overtake" other large ship traffic constrained by drafts as is the case for any ship of more than 50,000GT. Neither of these situations enables an accidental collision at a "steep" angle. This is especially true in the narrower channel of Desdemona Shoal Channel where it is not physically possible for a large ship to strike another large ship at a 90 degree angle.

[45] Sandia National Laboratories (SNL). "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water". Page 100

In the short transit distance from the river mouth, along Desdemona Shoal Channel, to the Oregon LNG Terminal site, there are no commercial cross traffic routes. There are no moorings where large vessels enter or leave the channel. Tug and barges service the Weyerhaeuser Facility in the Skipanon Waterway and Warrenton Fiber at Tansy Point. This requires the tug and barge combinations carrying primarily woodchips to enter and leave the ship channel but they are considerably less than 50,000 GT.

The turns in the channels, such as Tansy Point turn, and the turn from the Entrance Channel to Sand Island Channel, are areas where two ships could meet at an angle, although it would not be 90 degrees. The maneuver of an LNG ship moving from the shipping channel towards the dock location will create a location where a down bound ship could collide with an LNG ship being moved out of the channel into the turning basin. One must assume under an accidental scenario that the pilots aboard each ship would attempt to minimize the angle if possible once they recognize the error made to cause the collision. In addition there would be upwards of four large tugs assisting the LNG in mooring which could address the situation.

A collision that occurs when two ships are in a meeting situation would likely result at a high rate of relative speed. While we do not think it would cause a breach of a cargo tank since ships have a strengthened bow and collision bulkheads, and the ships would most likely receive a “glancing” blow, the possibility of cargo release could not be completely dismissed. A collision that occurred while two ships are in an overtaking situation would not have the same damaging effect because the relative speed would be much less and the angle of the collision would be shallow. Therefore it is not expected that an accidental collision that occurred during an overtaking situation would cause a breach.

Taking the above considerations into account, high speed collision scenarios were examined throughout the ship transit. Based on pilot history, the probability was considered low “1” both in and out of the river. The Consequence Scores were also low “1” with Zone “2” overlapping parts of the City of Warrenton which is a low population area. However, as discussed in Section 4.1.1 above, during the summer months the area around Buoy 10 was treated as a medium density population area. A

collision in this area would result in a Zone 1 overlap of a “medium density” population area. The Consequence Score for Zone 1 over Medium population density is “3”. During the summer months the City of Warrenton was treated as a medium population density so the Consequence Score is a “2” with Zone 2 overlapping a medium density population area.

(D) ALLISION WITH TERMINAL DOCK

This accidental scenario was considered since it is not unusual for some errors to be made when ships are mooring. The Bar Pilots have a very good safety record, with no significant incidents reported. While this part of the analysis is not supposed to consider mitigating strategies, it is already known that the company will employ tugs to assist in mooring the ships. At least three tugs will be used to control the ships throughout the maneuver to align the ship as appropriate to moor and to push the ship to the dock. Therefore, it was determined that even if the ship hits the dock harder than ideal upon mooring, it would not be hard enough to cause significant hull damage and would not cause a cargo tank breach. The Consequence Score was “N/A” resulting in a Risk Score of ”N/A”.

(E) CARGO HANDLING MISHAP

As was discussed in some detail at the Risk Assessment Work Shop held in Warrenton, there are a number of potential unintentional incidents that could occur that might result in a cargo handling mishap. The transfer system is designed/built to avoid or prevent large spills. As was the case when considering tugs, the design of the facility and safe guards are mitigation strategies, but they are known, and in fact required to be installed so they are considered in this section.

Automatic shut-off valves are designed to ensure any spill is only on the order of a liter or two of liquid. The system has been proven and was most recently tested when a ship at the Elba Island facility in Georgia was pulled off the dock because of the surge from a passing ship. The connections parted and the automatic shut-off valves worked as designed with little liquid spilled.

The Probability Score assigned to this scenario was low "1" as was the Consequence Score "1" because it was thought highly unlikely that a cargo handling mishap would result in a cargo spill of the magnitude evaluated in the Sandia Report. While this scenario was determined to be a low risk, further mitigation will be discussed in the following section regarding monitoring of cargo transfers and inspection of equipment and qualification of cargo transfer personnel. The Coast Guard is required by regulation to conduct the observation and inspections and verify training/qualifications of personnel.

(F) LNG SHIP BREAKS AWAY FROM MOORING

This accidental scenario was discussed at length in the Risk Assessment Work Shop. The risk of a Sandia sized release of LNG cargo occurring as a result of an LNG ship breaking loose as a result of a passing ship surge or a tsunami were determined to be low. As discussed in Section 3.3.4, in a tsunami event the tide level is expected to rise approximately 7 feet over the existing tide level. Since the dock height is being planned for 25 feet, the high water level will not be a problem for the mooring system. The current will reach about 4 knots in the flood directions, about 125 degrees true. That direction will tend to hold the ship on the dock and the ebb current is not predicted to exceed 5 knots which is not more than what can be experienced in normal situations.

The possibility of a passing deep draft vessel causing a wake of such size that it could impact the moored ship or the cargo transfer gear was addressed in Section 4.3.4 above. The "Mooring and Berthing Analysis, Oregon LNG Terminal" Report was developed by CH2M Hill, in part, to evaluate the impact of surge from passing vessels. CH2M Hill used the Naval Facilities Engineering Service Center computer program PASS-MOOR to estimate the forces imparted to a moored vessel. The Report concluded that, "Due to the relatively large distances between the mooring and passing vessel, as well as the adequate under keel clearance at the berth, the passing vessel effects are small, at most increasing the maximum mooring line tension

by 9%." [46] The Report took the analysis one step further and determined that, "... for wind speeds of 60 knots or less, the combination of wind, current and passing vessel will result in mooring line tensions that are within the allowable stress limits." [47]

The potential for an LNG vessel to break its mooring due to high winds was much more of a concern to several members of the Work Group. They made the contention that winds in the area do exceed 40 knots, at least as far as gusting. As discussed in Section 3.1.2, the ship mooring system is being designed to withstand a 56 knot sustained wind speed. (During the Risk Assessment the possibility of the ship being "stuck" in the river because the Bar conditions deteriorated to the point that pilot service is suspended was raised. The conditions at the Bar do not necessarily correlate directly to wind speed, but the pilots did report that the weather buoys provide a good predictive method of expecting high winds.)

The issue was examined as if it did occur and, absent any mitigating measure or response measure that would stop the ship, it is expected that under the high wind scenario that was so strong to break mooring lines, the winds from the south would push the ship to the north and eventually ground the ship on Desdemona Sands. Since the ship is drifting in this scenario, which ignores tug assist, the ships anchors, and the ship being able to use ship power to maneuver, it is not expected to cause enough damage to breach cargo tanks resulting in a Consequence Score of "N/A" and a Risk Score of "N/A".

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[46] "Mooring and Berthing Analysis, Oregon LNG Terminal." Prepared by CH2MHill. January 2008. Page 2-7.

[47] "Mooring and Berthing Analysis, Oregon LNG Terminal." Prepared by CH2MHill. January 2008. Page 2-7.

(G) LIGHT AIRCRAFT CRASH INTO MOORED SHIP

Since the proposed facility will be near the Astoria Regional Airport and is closely aligned with runway 13/31, this accidental scenario was considered. As discussed in section 3.7, the end of the runway is 1.6 miles away from the ship berth. The 13/31 runway is primarily used for Visual Flight Rules (VFR) so it is used primarily by light aircraft in good visibility. The vertical mast height of the largest LNG ships are approximately 174 feet and may be considered by the FAA to be "obstructions to air navigation." If a small aircraft strikes a ship mast accidentally, it would not result in a cargo tank breach, but is not a desired event. Accordingly, Oregon LNG will need to work with the airport manager and the FAA for a determination of the ship and facility tank heights in regard to the proximity to the airport. If it is determined that they are considered obstructions, the airport master plan and appropriate publications/reference material will need to publicize the information appropriately. *(Recommendation 7.3.2 (C) (15)).* Assuming that appropriate notifications/ publication is done as required by the FAA, the probability of this aircraft incident occurring was determined to be low as discussed in Section 4.4.1. Therefore a probability score of "1" was assigned to this scenario.

A light aircraft crashing on one of the LNG tankers in an accidental scenario would not cause a Sandia-size spill/fire. A light aircraft striking the side of the ship would not have enough mass/energy to penetrate the double hull of the vessel. There might be a fire alongside the ship from the aircraft but the LNG cargo inside the ship would not be affected. If the aircraft was unable to avoid crashing into the ship and struck the top of a tank in more than a glancing blow, it could potentially penetrate the tank top. Similarly, a helicopter that auto-rotates down onto a ship tank top is not likely to penetrate the tank top, but there are too many variables to completely rule the possibility out. Damage to a tank top would not result in the amount of spillage modeled in the Sandia Report. The fire would be isolated to an area on and around the immediate vicinity of the ship. Within minutes the fire, assuming there was ignition after a plane crash, would be isolated to the point source, or hole in the tank top. Since the fire that would result form this scenario would be much smaller than the "Sandia-size" pool/fire, it was given a Consequence Score of "1" with a resulting Risk Score of "1" .

4.5 SECURITY RISK ASSESSMENT

The security risk assessment evaluates the risk of intentional releases of LNG. As discussed in Section 4.1, risk can be defined as the product of probability and consequence. Whereas probability in a "safety" context is determined by historical trends or frequency of accidents/incidents over a period of time, probability of an intentional, terrorist type event, is defined as the product of threat and vulnerability. Accordingly, security risk is captured in the following equations:

Risk = Probability x Consequence

Probability = Threat x Vulnerability

Therefore, in a security scenario;

Risk = Threat x Vulnerability x Consequence

The "What If" tables for intentional incidents are attached in Appendix F. Those tables list the threat, vulnerability, and consequence considerations applied throughout the transit from 12 nautical miles offshore to the dock. Numerical values were assigned to provide a comparison and prioritization of the various threats and locations, which in turn is used to determine appropriate types and locations of mitigation strategies in the next section of this report.

4.5.1 Threat

Three possible approaches were evaluated for defining Threat in the Risk Equation described in Section 4.5 above:

- A calculated/estimated threat based on the threat characteristics of "motivation", "intent", and "capability" defined in Chapter 4 of the USCG RBDM Manual
- A local threat assessment for the Columbia River from the Coast Guard Captain of the Port (COTP)
- The National Maritime Security Levels

1. A Calculated/Estimate Threat - Chapter 4 of the USCG RBDM Guidelines breaks "threat" into the characteristics of "motivation", "intent", and "capability" in an attempt to develop a scoring methodology.[48] However, the Guidelines also warn that since threat is a function of vulnerability and consequence, "… we risk 'double counting' if we adjust the likelihood of the threat for a particular scenario based on our perception of the attacker's capabilities or the characteristics of the target being analyzed."[49] The guidance recommends that, "…since terrorists will also consider vulnerability and consequence, assigning a single (constant) value to threat … should result in a reasonable risk ranking…"[50]

2. A Local Threat Assessment - LT Shrad Shadrack of USCG Sector Portland, OR provided an unclassified (SSI) assessment of the overall threat of a maritime terrorist attack in the Columbia River at the Risk Assessment Workshop held at Warrenton, OR on October 31, 2007. LT Shadrack informed the work shop participants that there is currently no credible, specific threat to LNG ships anywhere in the United States including the Sector Portland Oregon Area of Responsibility. The maritime threat is considered low, conforming with the current Maritime Security Condition (MARSEC) Level One (MARSEC 1), or 'Yellow' under the Homeland Security Advisory System. (MARSEC 1 has become the post 9/11 'normal'.)

3. The National Maritime Security Levels - In accordance with the Coast Guard Federal Regulation, Maritime Security (MARSEC) Levels advise the maritime community and the public of the level of risk to the maritime elements of the national transportation system. More correctly, the MARSEC level defines the level of threat while the risk for each element of the national transportation

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[48] U.S. Coast Guard Risk based Decision-making for Maritime Security, Chapter 4. Page 4-23.

[49] U.S. Coast Guard Risk based Decision-making for Maritime Security, Chapter 4. Page 4-22.

[50] U.S. Coast Guard Risk based Decision-making for Maritime Security, Chapter 4. Page 4-23.

> system is determined based on the vulnerability of that system and the consequences of a transportation system security incident involving that transportation system. The Commandant of the Coast Guard sets the MARSEC Level consistent with the equivalent Homeland Security Advisory System (HSAS) Threat Condition and that Threat Condition's scope of application. Notwithstanding the HSAS, the Commandant retains discretion to adjust the MARSEC Level when necessary to address any particular security concerns or circumstances related to the maritime elements of the national transportation system. In addition, the COTP may temporarily raise the MARSEC Level for the port, a specific marine operation within the port, or a specific industry within the port, when necessary to address an exigent circumstance immediately affecting the security of the maritime elements of the transportation system in his/her area of responsibility.

Halcrow decided to adopt the MARSEC Levels as the best measure of Threat for use in calculating Risk Scores. The use of the MARSEC Levels as the basis for Threat recognizes that those with access to the intelligence information will make the decision that will in turn change the Risk Scores accordingly. In addition, this approach aligns with the COTP's authority to adjust the local MARSEC Level based on threats specific to the Columbia River.

The "What If" tables in Appendix F clearly show that as the MARSEC Level increases the unmitigated Risk Scores for each scenario also increase and additional mitigation measures must be employed to keep the Risk Scores at an acceptable level. In general, the "acceptable" levels of risk should not change with increases in the MARSEC Level. Instead, additional mitigation measures should be employed for each scenario to keep that scenario within a constant acceptable level.

4.5.2 Vulnerability Assessment

As described in NVIC 05-05, the purpose of a vulnerability assessment is to identify weaknesses or exposures that could be exploited by terrorists. To accomplish this with a consistent methodology throughout the transit, we adopted Table 5, "Vulnerability Categories" and Table 6, "Vulnerability Score" from enclosure (3) of

USCG NVIC 9-02. However, we modified the "Accessibility" category of Table 6 to take into account the deterrent effect of an LNG ship sailing at high speeds on the open ocean. While Table 5 in NVIC 9-02 "identifies geographic barriers that deter the threat without organic security," Table 6 did not have any verbiage that would reflect the deterrent effect of a ship sailing at high speeds in open water. In order to be able to reflect variances in Vulnerability Scores, and thus better differentiate the relative risks throughout the transit, the Accessibility category descriptors in Table 4-7 below were modified from those in Table 6 of NVIC 9-02 to reflect distances offshore, vessel speeds, restricted water, and boating density.

Table 4-6
Vulnerability Categories (Table 5, NVIC 9-02)

AVAILABILITY	The target's presence and predictability as it relates to the ability to plan an attack.
ACCESSIBILITY	Accessibility of the target to the attack scenario. This relates to physical and geographic barriers and distances to the target that deter the threat without organic security.
ORGANIC SECURITY	The ability of security personnel to deter the attack. It includes possible evasive actions by the vessel, security plans, communication capabilities, guard force, intrusion detection systems, and timeliness of outside law enforcement to prevent the attack.
TARGET HARDNESS	The ability of the target to withstand the specific attack based on the complexity of target design and material construction characteristics.

Table 4-7
Vulnerability Score (Modeled on Table 6, NVIC 9-02)

Category	Availability	Accessibility (External Threats)	Organic Security (Internal Threats)	Target Hardness
High (4)	Always available (continual presence or present daily on a set schedule)	No deterrence: Unrestricted access to the vessel: - Ship operating in protected waters - Ship limited in ability to maneuver - Slow speed, 10 kts or less - High boating	No deterrence: No security plan: - unrestricted internal movement - no guard force - no emergency communication, outside L.E. not available for timely prevention - No detection capability	Intent of attack easily accomplished (e.g., readily damaged or destroyed)

Category	Availability	Accessibility (External Threats)	Organic Security (Internal Threats)	Target Hardness
		concentrations - No escort vessels to deter/disrupt approach		
Medium (3)	Often available (e.g. present several times a week; arrival & departure times predictable 1 to 2 months in advance; predictable)	<u>Some deterrence:</u> - No access closer than 100 yard, and - Controlled access from 500 yard to 100 yard if in restricted/ protected waters	<u>Some deterrence</u>: Valid security plan including: - Access controls to keep unauthorized persons and materials off the vessel - Restricted areas/spaces identified and locked - Communications/Ship Security Alert System	Good ability to withstand attack (e.g. simple design but relatively strong construction)
Low (2)	Periodically available (e.g. present several times a month; arrival times & departure times not regular but predictable a week or two in advance.)	<u>Good deterrence:</u> - No access closer than 500 yards, OR - Difficult to approach due to : o Open ocean water o Ship traveling at high speed o Ship able to maneuver	<u>Good deterrence:</u> - Valid security plan and - Periodic security guard force (POSCON)	Target expected to withstand attack (complex design and substantial construction minimizes success of all but most sophisticated attacks)
Very Low (1)	Rarely available (e.g. no set schedule and on any given day presence highly unlikely/unpredictable; arrives once a year or less for a few hours and arrival is not publicly known)	<u>Best deterrence:</u> - No access within 1,000 yards, and - Security Zone enforced with sufficient escort boats equipped to respond/ defeat threat	<u>Best deterrence:</u> - Valid security plan/program, and -Continuous security guard force (POSCON), and - consider augmented POSCON Team	Target impervious to even most sophisticated multi-unit attack.

In Table 4-7 the “Availability” and “Target Hardness” categories are constants, while the two categories that provide differentiation are “Accessibility” and “Organic Security.” Therefore, since “Availability” and “Target Hardness” are constants and adding them into what would be simply a higher vulnerability score (adding a total of “6”

to the number) without helping to establish differentiation, the two scores were considered to be zero.

In addition, to better organize the thought process and simplify the scoring system, “Accessibility” and “Organic Security” were used to address the two kinds of threat vectors; either an external threat or an internal threat. In so doing, the nature of the threat, external or internal, determined the scoring category and that category score was the vulnerability score used.

Accessibility was considered to be the ability of an external threat to approach the ship to achieve the goal of attack. As listed in Table 4-7, the considerations involved the speed of the ship, whether the ship was in restricted waters or on the open ocean, which involves both the sea conditions and the maneuverability of the ship, the distance offshore, and the boating concentrations in the area. For example, if there is a small boat threat for a “USS Cole type” boat bomb attack, a ship traveling at sea speed (16-18kts) on the ocean with a wind driven chop is a challenge to maneuver a boat alongside and remain alongside to ensure the success of the attack, whereas a ship moving slowly in a restricted channel in protected waters is relatively easy to approach.

“Organic Security” was viewed as the level of organizational deterrence or onboard security that a ship has to deter or resist an internal threat such as hijacking. This security is provided primarily by the ship’s crew; however, the ship’s crew can be augmented with additional security forces placed aboard when the ships enter port. Since the implementation of the Maritime Transportation Security Act (MTSA) in the United States and the international equivalent, International Ship and Port Facility Security (ISPS) Code, all commercial ships and facilities involved in international trade are required to have security plans. These plans are intended to limit access to the ship by unauthorized personnel and screening cargo/equipment brought aboard as well as limits access to sensitive areas within the ship by unauthorized personnel of the crew. In addition, the plans outline required security rounds by trusted members of the crew, communications between the ship and facilities where they are moored, and establishing a warning/alert system.

4.5.3 Consequence Assessment

The Consequence Scores were determined the same as was done with safety/accidental scenarios and displayed in Table 4-5. Consequence in the context of an LNG cargo spill with the subsequent fire or vapor cloud was determined by matching the Zones of Concern with population densities to derive the Consequence Scores. Other consequences involved with a marine accident that do not involve a liquid cargo spill/fire are not addressed in this report since the consequences are much less severe/wide spread and would be similar to other large cargo carrying ships transiting the Columbia River. Consequences in this WSA are focused on the threat to public safety that the LNG cargo presents as directed in NVIC 05-05.

As mentioned previously in this report, the track line passes both Cape Disappointment State Park and Fort Steven State Park. As discussed in Section 4.1.1, both parks generally have what is considered a “low” population density for most of the year, but it was recognized that both swell to a “medium” category in the summer months since they often receive about 5,000 visitors a day. Likewise most of the City of Warrenton was considered to have a medium population density during the summer months due to the influx of a large number of tourists. This was taken into consideration when determining Consequence Scores. It was deemed appropriate in some cases, Hammond Point Marina and Tansy Point, to review specifically where the zones of concern overlap, particularly when the overlap is relatively small, so that the consequence is not overstated.

4.5.4 Unmitigated Security Risk Assessment

As discussed in Section 4.5 above, Risk in security scenarios is a function of Threat, Vulnerability and Consequence. The unmitigated Risk Scores for each of the security scenarios at each MARSEC Level is addressed in Section 4.5.7. The Risk Scores are calculated for each scenario by determining a Vulnerability and Consequence Score and multiplying these together. The results are shown in the three “Initial Score” columns in Appendix ‘F’. Appendices H, I & J provide the consolidated Scores at MARSEC Levels 1, 2 & 3 respectively.

4.5.5 General Security Assumptions

- The Sandia Report modeling results are accurate/reasonable in determining hole sizes and Zones of Concern for security scenarios.

- An attack on an LNG ship would happen while the ship is traveling along the designated track line, moored at the facility, or anchored.

- A successful attack on an LNG vessel in a “heel” condition would not result in a Sandia size LNG spill. In the Federal Register dated January 19, 2007 (Volume 72, Number 12) the Coast Guard determined that LNG vessels carrying only ``heel'' pose a minimal risk of an LNG spill. The definition of heel used in the FR was ”the minimum quantity of liquefied natural gas (LNG) retained in an LNG tankship after unloading at the LNG facility to maintain temperature, pressure, and/or prudent operations.” Therefore, the risk scenarios discussed below only address arriving (loaded) LNG vessels. Departing (unloaded) LNG vessels are not addressed unless for some reason the vessel is departing carrying more than the required “heel”.

- Pool burn times ranged from 20 minutes for a small intentional breach of two square meters to the nominal size hole for intentional acts of five square meters and a burn time of eight minutes (Table 14, pg 51 of Sandia Report). After an intentional act causing an LNG spill, if the ship was moving, it will continue to move even if power is lost. When looking at drift potential after a spill, or veering off course, we considered the fact that as time passes, the amount of spill will reduce as it falls astern of the ship and therefore the Zones of Concern may not be applied directly. For example, if the ship took four minutes to arrive at a position where it would come into the standard Zone 3 range of 3,500 meters from shore, it was not considered an appropriate application of Zone 3 because half of the pool spill had already occurred. (A ship traveling at 15kts would take four minutes to travel one nautical mile.)

- Sabotage by the ship’s crew is possible at any time.

- It is assumed in considering security/terrorist scenarios that the terrorists would want to cause damage to much more than just the ship, they would want the act to be highly visible so that they can claim they are striking a blow against the United States in an international forum. They also want to adopt scenarios that have a good chance of success, because they do not want to be embarrassed or "lose face".

4.5.6 Sensitivity

The sensitivity issues concerning the zones of concern and spill sizes are similar to those already discussed in the section discussing Safety, Section 4.4.5. In addition, it should be noted in this security/intentional act section that the unclassified Sandia Report did not specify the damage/hole sizes created by specific threat vectors. It implied that some threats were more substantial than others for breaching the hull/cargo tanks of LNG ships, but the specifics are discussed in a classified document. In accordance with the guidance in NVIC 05-05, the threats are all treated equally in terms of being able to cause a breach and create a Sandia-size spill. While this may establish a good, conservative planning baseline, it does not permit delineation of threat vectors. While each threat vector discussed might be able to create a breach under the right circumstances, it is clear that some threats are far more dangerous than others in the size hole that could be created.

It is presumed that the greatest credible threat in terms of "hole" size is the " USS Cole type" small boat attack because that is a demonstrated capability of the terrorist groups and that is the means of getting the largest amount of explosives alongside the LNG ship of the threat vectors reviewed. An attack by a large commercial airliner could also create devastating results, but that threat is considered much less credible due to the security layers now in place to board an airliner and the attractiveness of other targets that would be available to an aircraft rather than an LNG ship.

NVIC 05-05 directed that the air threat be addressed. As mentioned above, clearly a large commercial aircraft could penetrate the cargo tanks of LNG ships. It is much less likely that a light aircraft could. In fact, it is not expected that a light aircraft would have enough energy to penetrate the double hull of the ships. They could

penetrate the tank tops that do not have a double steel shell as thick as the sides of the ships. However, a hole at the top of a tank will not spill out as would a waterline hole that was modeled by Sandia.

After reviewing capabilities of many shoulder launched weapons, it was deemed appropriate to use 500 yards as a maximum effective range. That is the maximum effective range of a more common RPG-7. It is questionable that a shoulder launched weapon could penetrate the second, inner hull of a tanker. They are designed to penetrate steel and then expend their energy to kill personnel in a tank. They are not designed to penetrate steel plate, then go through a space of 3 meters and then penetrate another steel plate. There are stand-off weapons that are more capable in terms of penetrating power and range but the size, ease of use, and availability of those weapons makes their use much less feasible.

Similarly, mines come in many levels of sophistication. Thus far, terrorist groups have not demonstrated that they possess or are interested in the more advanced versions. They have demonstrated the ability to launch floating mines. These mines would create holes at the waterline which would be the objective for a terrorist targeting an LNG ship. Bottom mines that detonate below the ship might create serious problem aboard one of these ships but the cargo would not spill out as quickly as would be done from a waterline hit. Therefore, this assessment addressed the floating mine threat.

4.5.7 Security/Intentional Act 'What if' Scenarios

Security scenarios were examined throughout the transit from the ship's entry into U.S. waters at the twelve mile limit to the proposed facility mooring on the eastern Skipanon Peninsula. The list of threat vectors below was developed based on guidance found in NVIC 05-05. The "Hijack" vector was split from "Sabotage" since the two activities have different objectives in the context of these discussions. Both involve an internal threat to the ship, but sabotage is normally directed at the ship and/or crew while hijacking is normally intended to use the ship as a weapon directed at an external target. The specific attack scenarios listed were derived from each threat vector.

Threat Vector	Scenarios
Surface Attack	Small boat attack (USS Cole type – boat bomb)
	Ramming (large ship)
Projectile	Stand off Weapon from boat
	Stand off weapon from shore
Aerial Attack	Small aircraft
	Commercial aircraft
Underwater Attack	Mines
	Divers
Sabotage	Bomb aboard LNG ship
	Release of LNG
Hijack	Cause high speed collision with another vessel
	Ram cruise ship
	Ram Astoria-Megler Bridge

The "What If" work sheet tables in Appendix F were used to develop the possible attack scenarios. The work sheets list scenarios, potential consequences by location, proposed Risk Scores to be discussed for each scenario at each threat level along the track line, listed existing and proposed risk mitigation measures by the risk assessment working group and developed mitigation measures/scores for each threat level. The worksheets were reviewed and discussed by the Working Group. The scenarios and Risk Scores, when finalized by Halcrow were listed on summary score sheets in Appendices H-J to provide a better visual means to review the Risk Scores before and after application of the proposed mitigation measures to determine the usefulness of those measures. The following discussion summarizes the considerations and determinations for the risk for the scenarios listed on the worksheets and summary

sheets. A discussion of the proposed mitigation measures will follow in Section 5, “Risk Management Strategies”.

In general, the ship transit along the track line was viewed as being conducted in two different marine environments: offshore/open-ocean, and restricted waters in the river where the ship is constrained by draft and near land.

Offshore the ship has maneuvering room and can travel at a relatively high rate of speed. The sea conditions are normally rougher at sea rather than in the more protected waters of the river and winds are normally higher. These “at sea” environmental factors greatly impact the effectiveness of an external threat being able to successfully complete an attack on an LNG ship. Additionally, the consequences are significantly different if an attack is conducted when the ship is far enough offshore that any cargo spill/fire will not reach land.

The risk increases as the ship enters the river and it continues to progressively increase as the ship moves further upriver. This is due to the rough sea conditions often experienced in the river mouth, the width of the channels, distance of the track line from the shoreline, and increasing population densities as the track moves further up river. At the river entrance, the Entrance Channel and Sand Island Channel are both relatively wide at 2,640 feet and often experience significant swells since this is the area of the Columbia River Bar. The track line in this area is further from land until the track turns and transitions to the narrower Desdemona Shoal Channel which is 600 feet wide. The transit along the Upper Desdemona Channel in particular is where the track line gets closer to land, transiting along the shoreline of Warrenton. The closest point of approach of the track line to land is at Tansy Point where the track passes 400 yards (366m) offshore.

Therefore, as can be clearly seen in the summary score sheets, the Risk Scores show that the two primary areas of interest for most of the external threat scenarios are roughly between Buoy 10 and Buoy 14 during the heavy fishing seasons notably the August “Buoy 10” season, and along the track line from Hammond Marina until past the Tansy Point turn. Since Vulnerability Scores are relatively high throughout the river transit, the main differentiating scores are the Consequence Scores.

As with the accidental scenarios, the expanded Zones of Concern were used in anticipation of new Coast Guard guidance for the Q-MAX LNG ships when they are built and brought into service.

(A) SURFACE ATTACK

(1) Small Boat Attack ("USS Cole type") - The Risk Assessment Working Group agreed that the greatest threat to LNG ships was from a small boat, "USS Cole type", attack. This is both from the perspective of the ability to damage an LNG ship and from the demonstrated inclination of terrorist groups to use this mode of attack. It was recognized that the ships were more vulnerable to this type of attack once they enter the restricted waters of the Columbia River rather than offshore where the ships will be transiting at sea speed (15+ kts) through an ocean that will normally have some level of swell or chop.

The ships may slow down for embarkation of a pilot if being transferred by boat rather than helicopter, but the pilots generally board the ships 5-10 miles west of the "CR" buoy which is near or beyond 12 nautical miles offshore. The ship will also need to slow to embark a Coast Guard boarding team from a Coast Guard small boat. While that provides a small window of opportunity for a terrorist to make a small boat attack, the presence of a Coast Guard boat will deter an approach and the fact that times and location of those boardings vary will make the offshore scenario difficult to plan. An approach made towards the ship offshore would be more noticeable than one made in restricted waters.

In addition to the lower vulnerability offshore, the consequence of a successful attack offshore is also is significantly less. A Consequence Score of "0" was assigned to the part of the track beyond the range to shore of any Zones of Concern to reflect that the consequence was considered less than when the zones overlap land. A Risk Score of "0" was assigned along the inbound track to Buoy 4, which is where Zone 3 reaches land.

The Vulnerability Score, without consideration of any mitigation measures, from Buoy 4 to the dock was a "4". The difference in Risk Scores along the track line from Buoy 4 to the dock was based on the Consequence Scores for each geographic area.

For the segment of the track line that enters the river, extending from Buoy 4 through the remainder of the Entrance Range Channel and Sand Island Range Channel to the end of track leg 5, which is where the ship heads into the Desdemona Shoal Channel, the Consequence Score was determined to be "1" with Zone 3 overlapping low population areas.

The track line passes 1600 yards (1463m) south of the southernmost tip of land of Cape Disappointment State Park. It passes 700 yards south of Jetty A but approximately 1975 yards (1805m) south of Cape Disappointment at the base of Jetty A. To the south of the track, the track line closes to within 1800 yards (1646m) of the north shore of Clatsop Spit at the end of track leg 5. The track line also passes 1400 yards (1280m) west of Sand Island.

The ship track line is far enough off the shore that only the outer edge of Zone 2 overlaps the tip of Cape Disappointment State Park (approximately 350 m). As can be seen in the Charts in Appendix A and the Google Earth pictures in Appendix B, the Zone 2 overlap only entails the north jetty and a small tip of beach area. Even with an increase in the number of park visitors, this small beach area was not foreseen to have enough people in it to increase the population density so the area overlapped by Zone 2 was recognized as a low population area. Clearly Zone 3 overlapped a greater percentage of the Park and that was considered Medium population density in the summer.

Clatsop Spit to the south was overlapped by about 150 meters of Zone 2 and all of the northern head of Clatsop Spit was within Zone 3. However, the working group recognized that while Fort Stephens State Park does grow in population during the summer, most of that concentration is in the southern areas where the campsites are located. People go to the Northern head of Clatsop Spit to view the jetties, go hiking/beach combing, and other activities, but don't normally stay up there long since it is cooler. Therefore, the area of Clatsop Spit north of Jetty Lagoon was considered to have a low population density even during the summer tourist season.

As a result, the Risk Score for small boat attacks in the area roughly from Buoy 4 to Buoy 14 was a "4" with the exception of the busiest fishing seasons (June – Sept).

During this period there is a steep increase in the number of recreational/sport fishing boats. During the busiest of the fishing seasons, the "Buoy 10" season, the fishermen tend to concentrate their fishing near the river mouth border at Buoy 10 and the number of boats has reportedly been in the thousands. The boating density can potentially get so high between buoys 10 and 14 that the population could be considered Medium density. Accordingly, that area in that timeframe received a Consequence Score of "3", Zone 1 over medium density population, and a Risk Score for a small boat attack of "12".

The transit along Desdemona Shoal Channel brings the ship relatively close to shore. The two closest points of approach are the point of land on the north side of the Hammond Marina basin (550yds/503m) and Tansy Point (400yds/366m) where the Nygard Dock and Warrenton Fiber are located. The expanded Zone 1 overlaps the park north of Hammond Marina by about 60 meters. The Warrenton Fiber property is within the expanded Zone 1 by about 200m. The shoreline between the two points is beyond the expanded Zone 1 range of the track line, but clearly within Zone 2.

The Risk Assessment Work Group agreed that Warrenton also grew in population size in the summer to a Medium density since the vacationers going to the State Parks visit Warrenton to shop, sightsee, and eat, as well as some just staying in Warrenton for their vacation. The police chief noted the marked increase in traffic along the Fort Stevens Highway during summer. However, the small area of the Hammond Marina park area that falls within the Zone 1 overlap (approximately 60m) was not considered to grow so substantially that it would change the population density category. Similarly, the Warrenton Fiber business would not realize a seasonal increase such that it would increase its work force to increase the population density. Therefore, the Zone 1 overlap at the Hammond Park Marina and the Warrenton Fiber business was considered low population. The Zone 2 and 3 overlap areas of the part of Warrenton north of Tansy Point were considered to increase seasonally to Medium.

Because there is a high Vulnerability Score "4" and a Medium "2" Consequence Score, the Risk Score for the area between Hammond Marina and Tansy Point was "8" during the summer season.

As the ship turns away from Tansy Point on track leg 7 continuing the transit up river and heading for the planned turning basin for the facility dock, the potential consequence of an incident again changes. As the ship moves upriver, away from Tansy Point, Zone 1 no longer overlaps the Warrenton Fiber property. The overlap of Zones 2 and 3 of that part of Warrenton is similarly reduced while the Zones of Concern begin covering more of the Skipanon Peninsula and more of the southern area of Warrenton.

After the ship passes the midway point of track leg 7, heading towards the turning basin, the Zone 2 overlap of Warrenton is limited to only the Warrenton Fiber property on Tansy Point and some of the undeveloped land just to the south along the water of Warrenton Fiber, and the northern areas of the two Skipanon Peninsulas, which are all considered low population density. Since these are industrial areas, it is not considered to experience the seasonal increase of population. Zone 3 clearly continues to overlap Warrenton, shifting to the south and east as the ship would move in that direction. Also at the midpoint of track leg 7 the expanded Zone 3 begins to reach the City of Astoria which is categorized as a Medium population density area.

As the ship is maneuvered along track leg 8 to the dock the overlap of Zones 2 and 3 is further reduced in the Tansy Point area but increases to the south in Warrenton and Astoria. The Zone 2 overlap area of Warrenton is now over low population areas. The Zone 3 overlap is now covering Medium population densities year round (Warrenton on seasonal basis and Astoria year round). Therefore the Consequence Scores decrease to a “1” for this scenario as the ship negotiates the Tansy Point turn, enters the turning basin and is pushed to the dock. The Risk Score is “4”.

When the ship is moored at the terminal the situation is similar to track line 7 with an additional small Zone 1 overlap of the tip of the Skipanon Peninsula. The pier is approximately 560 yards (512m) from the tip of the peninsula creating an overlap of approximately 50 meters where the facility would be and is considered low population density and a Consequence Score of “1”. Zone 2 overlaps Warrenton Fiber property at Tansy Point by about 250m (1700 yards (1555m) from the proposed Oregon LNG Terminal pier) as well as some of the undeveloped land south of Tansy Point along the water front. The overlap of Zone 2 is considered a low population area. The Google

Earth pictures in Appendix C show that most populated areas fall outside of the Zone 2 arcs. The Weyerhaeuser saw mill is on the outer edge of Zone 2. Zone 3 clearly overlaps much of Warrenton and a swath of about 600 meters of the western part of Astoria. The probability of an unignited vapor cloud being created to the extent of Zone 3 is considered remote by Sandia. Therefore, the Risk Score attributed to this intentional scenario is a "4" at a MARSEC 1. The vulnerability is clearly high at the dock, but the Consequence Score is considered low, "1".

(2) Large Ship Ramming an LNG Ship – The large ship ramming scenario is premised on another commercial ship being hijacked and purposefully driven into an inbound (loaded) LNG ship. As mentioned earlier, the Sandia Report determined that it would take a ship of over 50,000GT hitting the LNG ship at a right angle and a speed over 7 knots to penetrate the cargo tank (or possibly a smaller one with an unusually sharp bow).

The "Large Ship Ramming" scenario received fairly low Risk Scores because of the difficulty, almost impossibility, of a large commercial vessel ramming an inbound LNG vessel at a sharp angle and because of the planning/execution challenges of getting people and weapons aboard a ship to conduct the hijacking and the challenge of trying to plan on ship schedules.

As with the small boat attack scenario discussed above, the offshore transit for the "Large Ship Ramming" scenario was given a Risk Score of "0" because the Zones of Concern do not overlap land resulting in a Consequence Score of "0". The inbound transit along track leg 2 that starts from a position near the "CR" Buoy and goes to Buoy 4 was listed separately from the open ocean track further offshore simply to reflect a little higher vulnerability since the ship enters a marked channel and the possibility of passing closer to other large ships. The Consequence Score is still "0" due to the distance offshore so the Risk Score remains "0".

A very conservative Vulnerability Score of "3" was assigned throughout most of the river transit since it would be difficult, if not physically impossible, for two large ships to ram at right angles in the ship channels.

In the river mouth where the ship channel is 2,640 feet wide, there is some room for ships to maneuver and establish more of an angle for a collision, but weather conditions and currents will make ship handling more difficult. Attempting to ram another moving ship at a right angle would take a very skilled and practiced ship handler. The ships will be traveling at a higher speed in the outer channel, but the LNG ship will slow to hook up the escort tug(s) somewhere in this area. Ship schedules are fluid and someone attempting to hijack a vessel for this purpose would not be able to plan on a meeting situation with another underway ship in a specific location.

Once in Desdemona Shoal Channel, the channel width is only 600 feet and the ships would not be able to collide at much of an angle at all. However, two ships in a meeting situation could collide with a high relative speed. If the inbound LNG ship is traveling at 10 kts and the outbound ship is traveling at 12 kts, the relative speed of a bow-on impact could be as high as 22 kts. Ships have spaces in the bow area and are built with collision bulk heads so it is not deemed likely that a head-on collision would breach a cargo tank, but the possibility could not be ruled out, which is why the unmitigated Vulnerability Score was determined to be a “3”.

It should also be noted that the ramming scenario of underway ships only applies in a meeting situation where a high relative speed between ships is generated. It is not deemed feasible that a ship attempting to ram an inbound LNG ship while passing the ship from astern could generate enough relative speed or angle of impact to cause a breach in the LNG cargo tanks.

The Consequence Score for each leg of this scenario was “1” except for track legs 3-6 during the heaviest fishing seasons (June – Sept) and track Leg 6 during the summer tourist season. Considering the above discussion, the unmitigated Risk Scores in the summary sheets reflect that the area between Buoy 10 and 14 during the heaviest fishing seasons (June – Sept) and between Hammond Marina and Tansy Point during the summer tourist season warrant consideration. In addition, the other location that provides an opportunity for a “hijacked” ship to get a good angle on an inbound LNG ship is when it is being pivoted around in the maneuver for mooring. The Vulnerability was scored high because that is one place where the side of the underway

LNG ship might be exposed, but the location does not receive a very high Consequence Score.

A Vulnerability Score of "4" was assigned while the LNG vessel was moored dockside since the ship will have its outboard side exposed to the ship channel; however, the Consequence Score was only a "1" resulting in an unmitigated Risk Score of a "4".

(B) PROJECTILE ATTACK

(1) Stand-off Weapon Fired from a Boat - The risk assessment for a shoulder launched weapon being fired from a small boat is similar to the small boat, USS Cole type attack. In some ways the use of a stand off weapon is easier for the terrorist, since it would require less boat handling skills, but the damage caused by a stand off weapon would not be as extensive as the damage that would be caused by a large amount of explosives in a shaped charge held on a small boat.

Appendix Q provides information on some of the more common types of shoulder launched weapons. The maximum effective range varies from 300 meters to 500 meters and more often to the lower end of the ranges. Clearly there are more sophisticated missiles that can have extended range and penetrating power, such as a Tube launched Optically tracked Wire guided Missile (TOW), but they are more difficult to acquire, larger, heavier, and so more difficult to smuggle into the United States. They are more difficult to transport and set up, particularly when talking about firing a weapon from a boat. Rocket Propelled Grenades ('RPG'), which are known to be common among terrorist groups, are portable so that they can be used from a vessel or from shore.

As with the small boat attack, the unmitigated Vulnerability Score for this scenario is "4" for each of the legs with the highest "Consequence Scores" between Buoys 10 and 14 during the busiest fishing seasons (June – September) and between Hammond Marina and Tansy Point during the summer months

(2) Stand-off Weapon Fired from Shore – As mentioned above, only the lighter shoulder launched weapons were considered viable means of attack in this

report. The maximum effective range used was 500 meters. Based on that premise, there were two locations on shore that were deemed feasible: the point of land at Hammond Marina basin and Warrenton Fiber on Tansy Point.

The point of land by Hammond Marina is 503 meters from the channel which is just beyond maximum effective range, but it was close enough that we addressed it. Because of the extended range, it was given a low Vulnerability Score of "2". In addition, when firing the weapon at that range, it would be very difficult to aim a shot at the waterline. It would be much more likely that, to ensure a hit on the target, the shooter would fire high, which would significantly limit the amount of cargo spilled if the breach was accomplished. Never the less, a Consequence Score of "2" was assigned as Zone 2 would overlap a medium density population area during the summer months. The unmitigated Risk Score was "4".

Since the track line passes closer to the Nygard Docks/Tansy Point at about 400 yards (366m), it was determined to be a more likely scenario. The Vulnerability Score was raised to high "4" which in turn resulted in a unmitigated Risk Score of "8".

(C) AERIAL ATTACK

(1) Small / Light Aircraft Attack – The Vulnerability Score for a light aircraft attack was a "4" throughout the transit and at the dock because of the accessibility of the ship by an aircraft. With the proximity of Astoria Regional Airport and some other small airfields, there is no problem of reaching the ships by plane. Since NVIC 05-05 directed that the WSA address the air threat and the Sandia Report does not specify which aircraft were capable of crashing into the side of LNG ships and penetrating the double hulls, the threat was listed as credible. However, the participants in the Risk Assessment Workshop recognized that a "Cessna-type" light aircraft only weighs a few thousand pounds and would not realistically create enough energy to get through the two hulls and cargo tank insulation, even if the aircraft were carrying explosives. The possibility of a small jet, such as a Lear jet, with its greater weight and higher speed might be a feasible threat to penetrate a cargo tank.

In addition to the uncertainty of the light aircraft penetrating the ships hulls, it would be difficult to fly an aircraft into the side of a ship near the waterline. Even an

experienced pilot would not want to fly too close to the water for fear of crashing too soon, especially if the aircraft was a jet flying at very high speed. Therefore the strike on the side of the ship would be significantly above the waterline, which will limit the quantity of LNG spilled. The amount of cargo that would be released and the appropriate Zones of Concern would be smaller, possibly much smaller, than the Zones of Concern specified in the Sandia Report and used here. To again error on the conservative side we assumed a Sandia sized spill.

Weather would also impact the vulnerability. In the case of an air threat, poor weather would actually reduce the vulnerability of the ships. Restricted visibility would make them more difficult to locate for an aircraft flying under Visual Flight Rules (VFR). Higher sea conditions and higher winds would make an approach to the ship more difficult and would likely result in the aircraft hitting the ship higher than it would in calm conditions, which would further reduce the spill size assuming it did penetrate the hulls.

The Consequence Scores again drove the locations of concern. The area near Buoy 10 during the busiest fishing seasons (Jun – Sept) and the transit between Hammond Marina and Tansy Point received Consequence Scores of “3” and “2” respectively resulting in unmitigated Risk Scores of “12” and “8”.

When an LNG ship is at the dock, the Vulnerability Score remained “4” since the vessel is now a fixed target. The dock itself helps reduce the vulnerability by blocking access to the ship on the landward side. The distance of the dock offshore alone establishes a low Consequence Score, “1”. The fact that the breach would occur on the side of the ship away from the land/population, providing shielding from the radiant heat involved in a fire further emphasizes the low “1” consequence of such an attack.

(2) Commercial Aircraft Attack – Due to the FAA security regulations currently in place, the vulnerability of an LNG ship being attacked by a commercial aircraft is much lower than with general aviation aircraft and Vulnerability was scored as a “1” throughout the scenario.

The Commercial Aircraft Attack scenario presumes terrorist(s) have seized control of a commercial aircraft to fly it into an LNG vessel. Hijacking a commercial

aircraft is a very difficult task. All passengers of commercial aircraft are screened prior to boarding to ensure proper identification, matched against databases, scanned by metal detectors, and x-ray baggage, both hand-carried and checked. Additionally, there are TSA personnel in airports trained to recognize suspicious psychological profiles. Once on the aircraft, aircraft frequently carry "Air Marshals" and the forward cabins are now locked to prevent hijacking. Aircraft have frequent communications with their respective flight services ground control and can quickly communicate problems aboard. Therefore the Vulnerability Scores were "1".

The Consequence Scores were the same as those in the Small Aircraft scenario. As a result, the unmitigated Risk Scores for the Commercial Aircraft scenario were significantly less than the unmitigated Risk Scores of the Small Aircraft scenario.

(D) UNDERWATER ATTACK

(1) Mines – Mines, particularly drifting/floating mines, are indiscriminate weapons designed to deny the use of a port or waterway rather than to target specific vessels. In all but the most sophisticated systems, which are difficult to obtain, mines are designed to detonate when any vessel comes into contact with them or travels over them.

Terrorists have demonstrated the ability to deploy drifting/floating mines so they are the weapons addressed in this assessment. There are many other types that can seriously damage a ship, primarily bottom mines, but they are much larger and therefore more difficult to obtain and deploy. While drifting mines are already large with approximate weights around 120 kilograms, or 265 pounds, bottom mines range in size from 330 – 3300 pounds and would be much more difficult to deploy.[51]

Vulnerability to mines during the offshore transit was considered very low due to the wide area involved. The track line drawn on the chart approaching the Columbia River from the 12 mile limit is only representative of what the ships will do. There will likely be variations on that track based on where the pilots are actually embarked,

[51] Wikipedia – www.wikepedia.org/wiki/Naval_mine

where the Coast Guard boarding team embarks/disembarks, if the pilots choose to adjust course due to weather/tides/current conditions, or it the ship course is adjusted to avoid other vessel traffic. This variation actually helps reduce vulnerability since trying to place a mine offshore where a ship will pass is difficult. The amount of uncertainty in this offshore scenario in addition to the very low consequence involved for an event offshore resulted in this scenario being scored with a very low risk.

In theory, mining a restricted channel is a more viable threat than deploying mines off shore. However, mining the Columbia River would still be very difficult due to the extremely strong and variable currents and other vessel/ship traffic transiting the area. Assuming a terrorist organization was able to smuggle in, or build, a mine of sufficient size/capability to penetrate the double hulls of a large tanker, they would need to "place" the mine along the track line ahead and fairly close to an inbound LNG ship in order to ensure that the mine did not drift off the vessels track and that the mine was not struck by another passing vessel.

Without any mitigation measures, i.e. armed escorts, the ability for a small vessel to cross ahead of an inbound LNG ship at close range to quickly deploy a mine was deemed feasible. Therefore, this scenario was given a Vulnerability Score of "3" throughout the river transit. Consideration was given to have a lesser Vulnerability Score in the mouth of the river where the channel was wider and the currents more variable, but without a means to keep the attacking vessel further from the ships, the Vulnerability Score was kept constant, knowing that the different Consequence Scores would provide some differentiation in Risk Scores.

With the Vulnerability Score constant throughout the transit up the river, the different unmitigated Risk Scores calculated in appendix F are based on the Consequence Score of a successful mining attack along the different track legs. The Consequence Scores and resulting unmitigated Risk Scores were highest along the track leg between Buoys 10 and 14 during the busiest fishing seasons (June – Sept), and the track leg between the Hammond Marina and Tansy Point.

The Vulnerability Scores along track leg 8, through the turning basin maneuver and to the dock, was much less than along the other track legs because of all the tug

activity that will be conducted in the area. A vessel placing objects in the water would be seen by the tugs operating with the LNG vessel.

(2) Divers – The threat of a scuba diver attack on an LNG ship was considered to be low. A diver attack on an underway ship was not considered credible anywhere along the transit because of the speed at which the vessel would be moving. Even when moored at the dock, the working group recognized that the Columbia River is not an easy area to dive due to the strong currents, low visibility, and cold water. In addition, the amount of explosives that would be necessary to penetrate the ship into the cargo tank would be significantly more than the typical Limpet mines associated with the diver attack.

A very conservative Vulnerability Score of "3" was assigned to the unmitigated dockside scenario in recognition of the fact that with no mitigation measures in place a diver could use a small boat to enter the water near the moored LNG ship. With a Consequence Score of only a "1" (Zone 1 & 2 over a low population area and Zone 3 over a medium population area) the resulting unmitigated Risk Score for this scenario is a "3".

(E) SABOTAGE

(1) Bomb detonated aboard ship – The scenarios explored in this category dealt with a person, or persons, whether a terrorist or disgruntled employee, smuggling explosives aboard an LNG vessel and detonating the explosives so as to breach one or more cargo tanks. This scenario assumes the attack is done clandestinely; the terrorists do not hijack the vessel. (Hijacking is addressed as a separate scenario below).

To achieve a full Sandia-size LNG spill, explosives would need to be placed on the inside of the outer hull near the waterline and on the outside of the inner hull. To accomplish this, the attackers would need to access the space between the double hulls. Access into these spaces is through relatively small manholes which are tightly bolted in place. In addition, the spaces are inerted requiring an attacker to wear breathing equipment while in the space.

An alternative and easier attack mode would be for the attackers to place the explosives somewhere on one or more of the tank tops. While this could penetrate the cargo tank(s) and cause a spill/fire, the location of the breach near the top of the tanks would limit the amount of cargo spilled to a significantly lesser amount than what was modeled in the Sandia Report.

Again a conservative Vulnerability Score of "3" was assigned to this unmitigated scenario. While recognizing the difficulty of the attack scenario, it was determined to be a feasible scenario if no security measures were implemented on the vessel to address the threat. The highest unmitigated Risk Scores for this scenario were again along the track legs by Buoy 10 during the busy fishing seasons, "9", and between Hammond Marina and Tansy Point, "6", due to the higher Consequence Scores.

(2) Intentional Release of Cargo – The intentional release of LNG was given very low unmitigated Risk Scores for both the underway and dockside scenarios due to the difficulty of completing an unauthorized release of cargo and the relatively small amount of cargo that could be released.

The transfer/offload of LNG cargo, both authorized and unauthorized, is a multi-step, time-consuming process that requires a great deal of expertise and coordination among several crew members. The attacker(s) would first need to line up the transfer system using heavy wrenches to open the proper manifolds. Then the attacker(s) would have to go back to the control room to start the proper cargo pump(s). Starting-up a cargo pump requires starting a second generator in the engine room, which also requires closing a main breaker in the engine room to get power, then closing breakers for each specific pump to be used, which are in a separate compartment. Assuming a 1,250 cubic meter per hour pump capacity, it would require ten pumps to be energized to pump 12,500 cubic meters of LNG in an hour, which is the amount modeled by the 2004 Sandia Report in a virtually instantaneous spill. This slower rate of release would significantly reduce the pool size and the resulting Zones of Concern. The vapor cloud would dissipate well before reaching a size comparable with the model for Zone 3, particularly with the ship underway.

Based on the above discussion both Vulnerability and Consequence received low scores. The Vulnerability Score for the dockside scenario was increased slightly over the underway scenario because transfer operations are being conducted.

(F) HIJACK

This scenario involved an internal threat with one or more crewmembers taking control of the vessel to use the vessel as a weapon and or for releasing the cargo at some predetermined location. This threat is not limited to the vessel's planned track line since the hijacker(s) could redirect the ship to the desired objective. For example, the hijacker could simply intend to take control long enough to steer the ship into another large vessel to create the ramming scenario or the vessel could be navigated to a specific target and the cargo tanks breached to release the cargo.

The number of potential scenarios is extensive so a review of the area and vessel traffic was conducted and five worst case scenarios were developed and evaluated. The scenarios were viewed from two different perspectives. One is that the intent of the hijacking is to cause a collision with another ship to cause a breach of cargo and the other was to take over the ship to direct it to a specific location where the ship's cargo could be used as a weapon. That could involve ramming the target, but since that could be done with any large cargo ship, this primarily focused on somehow causing a cargo tank breach to cause damage.

In all cases, it was recognized that getting people integrated into a ship's crew along with smuggling explosives aboard was not easy. There would have to be enough people involved with the necessary skills to successfully accomplish the tasks required, whether that involved setting/detonating explosives, using weapons to control the rest of the crew and assume control of vital spaces such as the bridge and engine room, piloting the ship, communicating on the radio if external assets were involved, etc. Accordingly, vulnerability was considered low or medium even before other mitigation measures were considered.

(1) Hijack an LNG Ship to Collide with an Outbound Cruise Ship – This scenario was only considered once an LNG ship entered the Columbia River. There is much too much sea room offshore to conduct this attack scenario with even a remote

chance of reliably succeeding. Also an attack offshore would result in a Consequence score of "0" as the resulting Zones of Concern would not overlap land. Even in the River this scenario would only apply to a meeting situation with a loaded inbound LNG vessel and an outbound cruise ship. As discussed previously in this report, there would not be enough relative speed generated from an overtaking situation to cause a cargo tank breach.

Coordinating the attack would be very difficult. While the schedule of the cruise ships is much more predictable than most other commercial ships, the schedule of the inbound LNG ship may not be consistent considering the length of time required of the scenario planning. The terrorists would have to be aboard for the entire ocean transit from the source and there could be a number of reasons the LNG ship might be delayed, such as weather, mechanical difficulties, pilot availability, etc. Therefore, the Vulnerability Score for this scenario was considered low and given a Vulnerability Score of "2". However, if the scenario succeeded the potential Consequence was considered high since cruise ships are considered key assets and have a high population density. Therefore, this scenario was given a Consequence Score of "3" with a final unmitigated Risk Score of "6".

(2) Hijack an LNG Ship to Ram the LNG Facility Mooring – This scenario addressed the potential for someone attempting to take over the ship to ram the LNG terminal mooring, and possibly detonate a bomb aboard in order to assure a release of cargo. The Risk Assessment Work Shop participants did not view this as a credible scenario since it would be unlikely to do much damage other than to the pier. The cargo tanks ashore are far enough from the berth that they would not be harmed. The assist tugs would also hamper this attempt. Even though a very conservative Vulnerability Score of "3" was selected, the Consequence Score of only "1" results in an unmitigated Risk Score of "3".

(3) Hijack an LNG Ship to Attack a Moored Cruise Ship in Astoria – To develop the worst case scenario for a shore side population, this scenario called for a hijacker to navigate an LNG vessel alongside a moored cruise ship where the hijackers would work in conjunction with a small boat to detonate alongside for cargo release. This would create the "worst case" consequence since the Zones of Concern would

overlap both the moored cruise ship and parts of downtown Astoria. As discussed earlier in the report, this scenario would be very difficult to plan/coordinate. However, it was also recognized that it would be somewhat easier to coordinate an attack on a moored cruise ship rather than an underway cruise ship. Therefore, the Vulnerability Score for this scenario was a "3" versus a "2" in the scenario where the cruise ship is underway. The Consequence Score was a "3" resulting in an unmitigated Risk Score of "9".

(4) Hijack and LNG Ship to Attack the Astoria – Megler Bridge - This scenario again has the hijacking objective near the Astoria waterfront. This time it would be to take the ship near the Astoria-Megler Bridge and ignite the cargo either using a bomb aboard the ship or with a small boat alongside. This scenario not only would impact the population in Astoria, but potentially damage the bridge which is considered critical infrastructure. As with the moored cruise ship scenario, this scenario was given a "3" for vulnerability because the Megler Bridge is fixed. A Consequence Score of "3" was assigned because of the possible damage to the bridge, critical infrastructure, and the Zone 1 and 2 overlap over a medium population density area. The resulting unmitigated Risk Score was "9".

(5) Hijack and LNG Ship to Attack Targets Further Upriver Including Portland/Vancouver – This potential scenario was discussed with the participants of the Risk Assessment Workshop and dismissed as not credible. Only a Columbia River Pilot has the necessary local knowledge to successfully navigate an LNG up the Columbia River and they would not be on an LNG ship. The Columbia River Bar pilots, who would pilot the LNG vessels to the Oregon LNG Terminal, do not have the required local knowledge to navigate a seized LNG vessel up the Columbia River, east of the anchorage. With so much uncertainty of success it is not credible that a terrorist would plan it or attempt it.

5. RISK MANAGEMENT STRATEGIES

The intent of this section is to:

- Systematically identify which of the scenarios addressed in Section 4 pose a sufficient risk so as to require implementation of mitigation measures; and

- Define specific mitigation measures to reduce those scenarios to an acceptable risk level.

Section Four and Appendices E & F developed Risk Scores for each of the scenarios. In the safety/accidental scenarios Risk was calculated as a function of probability and consequence. In the security/intentional scenarios, Risk was defined as a function of threat, vulnerability and consequence.

In this Section, Tables 5-1 and 5-2 were developed using NVIC 9-02 guidelines to define acceptable levels of risk and thereby determine which of the scenarios addressed in Section 4 require the implementation of mitigation measures to reduce the risk to the acceptable level. Specific risk mitigation measures for each of the identified ”high” risk scenarios are then addressed.

Enclosure 3 to NVIC 05-05, the “Risk Management Quick-Reference Tool”, was used as a reference/starting point for identifying potential risk mitigation measures. The NVIC states that, “The intent of this enclosure (Enclosure 3) is to provide matrices that can be used as a quick reference tool to ensure all the accidental and intentional release scenarios identified in the Sandia Report are considered when preparing or reviewing a Waterway Suitability Assessment for LNG marine traffic…”[52] However, the NVIC also states that the matrices are not intended to force the use of strategies that may not be effective for specific ports or prevent the use of others.[53] The strategies

[52] USCG Commandant Publication P16700.4, NVIC 05-05, Enclosure (3) dtd June 14, 2005

[53] USCG Commandant Publication P16700.4, NVIC 05-05, Enclosure (3) dtd June 14, 2005

listed in the NVIC are comprehensive, but general in nature. Accordingly, this WSA includes evaluation matrices developed independently to determine the "site specific" requirements for risk mitigation along the transit route using the Risk Scores developed and discussed in the previous section.

Once the proposed risk mitigation measures were completed and checked for effectiveness, they were then compared to the risk management strategies in Enclosure (3) of NVIC 05-05 to ensure all strategies were considered. Tables 5-3, "Risk Management Strategies & Risk Mitigation Measures for LNG Ship Underway", and Table 5-4, "Risk Management Strategies & Risk Mitigation Measures for LNG Ship Moored", provides a side by side comparison of which of the mitigation strategies listed in Enclosure 3 were recommended by Halcrow. Again, the goal of this comparison was to ensure that all mitigation measures were addressed and to check for reasonableness.

5.1 RISK MANAGEMENT STRATEGIES FROM NVIC 05-05, "RISK MANAGEMENT QUICK-REFERENCE TOOL"

The "Quick-Reference Tool", identifies potential "Risk Management Strategies" for a series of different "Risk Factors" and "Attack Vectors & Accident Types". Separate matrices are provided for underway LNG vessels and moored LNG vessels. The Quick-Reference Tool does not mandate the use of any of the strategies but rather classifies them as, "recommended", "optional", or "not likely to have an impact".

The fourteen Risk Management Strategies for an underway LNG vessel are:

- Pre-Arrival Security Boarding
- Pre-Arrival Safety Inspection
- Safety/Security Zones and RNAs
- Vessel Escort for Safety/Security Zone Enforcement
- Positive Control Measures
- Commercial Tug Escorts
- Day Transit Only

- Electronic Surveillance of the Waterway
- Restrictions on Commercial and Public Activities
- “Police Presence” on Piers along Waterway
- Presence by Air
- Warning Signals for Community
- Areas of Refuge for Community
- Educational Program for Community

The fifteen Risk Management Strategies for a moored LNG vessel are:

- Pre-Arrival Security Boarding
- Pre-Arrival Safety Inspection
- Safety/Security Zones and RNAs
- Vessel Escort for Safety/Security Zone Enforcement
- Electronic Surveillance of the Waterway
- Restrictions on Commercial and Public Activities
- “Police Presence” on Piers along Waterway
- Presence by Air
- Warning Signals for Community
- Areas of Refuge for Community
- Educational Program for Community
- Diver Sweep of Pier
- Anti-Boat Barriers
- Physical barrier around moored vessel (slip)
- Cargo transfer Monitoring

The four “Risk Factors” used in the Reference Tool (“Moored” and “Underway”) are:

Risk Factor 1 – Transit/Moored Near High Population Areas. The Reference Tool identifies mitigation strategies that should be considered to reduce risk anytime an LNG ship's track line or mooring is within 3,500 meters of a high density population area.

NOTE: As discussed in Section 3.5, expanded Zones of Concern were used to address the potential for the larger Q-MAX class LNG vessels. These same expanded Zones of Concern were used in addressing these Risk Factors.

Risk Factor 2 – Transit/Moored Near Medium Population Areas. The Reference Tool identifies mitigation strategies that should be considered to reduce risk anytime an LNG ship's track line or mooring will approach within 3,500 meters of a medium density population area.

NOTE: The Reference Tool does not recommend mitigation strategies where a Zone of Concern overlaps a low density population (less than 1000 people/square mile). This WSA did consider low population densities for risk scoring purposes to provide a more comprehensive perspective when considering mitigation strategy requirements. It also took into consideration seasonal increases in population density for summer tourism/vacationers to include the two State Parks, most of the City of Warrenton and the fishing grounds between Buoy "10" and Buoy "14" as medium density.

Risk Factor 3 – Transit/Moored Near Critical Infrastructure and Key Assets. The Reference Tool recommends that mitigation strategies should be considered if an LNG ship will transit or moor within 1,600 meters (1,800 meters expanded zone) of critical infrastructure.

NOTE: The Astoria-Megler Bridge is the only critical infrastructure near the planned track line and that is approximately 3,750 meters from the ship's mooring location. While this does not require consideration based on the planned track line, the proximity to the bridge was taken into consideration when developing hijacking scenarios. The only key assets which pass within 1,800 meters of the transiting or moored LNG ship are cruise ships. Naval ships may also pass within that distance of a transiting/moored LNG ship. However, the lack of frequency and predictability of those

occurrences were deemed too difficult to plan and when they do arrive/depart, the security measures for those ships involved is already on par with that being proposed for LNG ships and therefore not considered as a separate scenario.

Risk Factor 4 – Transit/Moored Near Areas of Heavy Marine Traffic. The final "Risk Factor" identified by the Reference Tool is "Transit near Areas of Heavy Marine Traffic". Footnote 4 of Section A of the Reference Tool defines "Areas of Heavy Marine Traffic" as "… areas of the waterway that are congested with commercial, military, and/or recreational vessels (marine events and seasonal activities such as regattas, fisheries, etc.)." The term "heavy" and "congested" are relative terms.

NOTE: The area between Buoy 10 and Buoy 14 was considered an "area of heavy marine traffic" during the busiest fishing seasons (Spring Salmon, Sturgeon and "Buoy 10" seasons). For planning purposes, it was considered heavy and accounted for in the scenarios as causing an increase in population which required mitigation. However, from a practical standpoint, flexibility should be included in the security planning (Vessel Traffic Management plan) to account for years when the fishing is slow and the fishing boat traffic is light. While there can be a number of commercial and recreational fishing vessels as well as other recreational and commercial vessels near the mouth of the Columbia River entrance, it was considered a wide enough area and the vessel spread out enough that it was not designated an "Area of Heavy Marine Traffic" under this context. The ocean sport salmon season clearly increases the boating but by keeping the fishing limited to west of the line between Buoys 4 and 7, it creates a much wider area for the boats to fish and less density in the immediate area of the track line. It was not considered "congested" under this context.

5.2 RISK MITIGATION REQUIREMENT DECISION PROCESS

Section 4 of this WSA calculated unmitigated Initial Risk Scores for each of the safety and security scenarios. The next step is to determine, based on these unmitigated Risk Scores, which of the safety and security scenarios require additional mitigation measures to reduce the calculated risk to an acceptable level. The security scenarios then need to be evaluated at each of the three MARSEC Levels.

Tables 5-1 and 5-2 in the following sub-sections were developed based on Table 7 in Enclosure (3) to NVIC 09-02 to define levels of acceptable risk/desired actions for accidental and intentional risk scenarios.

5.2.1 Risk Mitigation Measures Criteria for Accidental Incidents

Table 5-1, which is based on Table 7 of NVIC 09-02,[54] delineates how the various Risk Scores listed in the "What-If" Table for "Safety/Accidental Scenarios" (Appendix E) are categorized to determine if mitigation measures are necessary.

Table 5-1
Probability & Consequence Matrix

Consequence				
	High (3)	Consider (3)	Mitigate (6)	Mitigate (9)
	Medium (2)	Document (2)	Consider (4)	Mitigate (6)
	Low (1)	Document (1)	Document (2)	Consider (3)
		Low (1)	**Medium (2)**	**High (3)**
		Probability		

By matching and multiplying the consequence and probability scores in the appropriate boxes in the table, the levels of acceptable risk/ desired actions for Accidental Scenarios are determined and displayed in Table 5-1(a) below.

Table 5-1(a)
Risk Score Categories "Accidental Scenarios"

Recommended Action	Risk Scores
1. Document	1-2
2. Consider	3-5
3. Mitigate	6-9

[54] Enclosure (3) to NVIC 9-02, Change 2. Page 8.

In accordance with the guidelines in NVIC 9-02, Change 2:

- "Document" means that the target/scenario combination examined does not need mitigation but is documented for future consideration should the situation change.

- "Consider" means that the target/scenario combination should be considered and mitigation strategies developed as deemed appropriate on a case by case basis.

- "Mitigate" means that mitigation strategies/measures should be developed to reduce risk for that target/scenario combination.

5.2.2 Risk Mitigation Criteria for Intentional Acts Scenarios

Similar to Table 5-1 for safety scenarios, Table 5-2 below provides a decision making tool to help determine if actions are needed to mitigate risk from security/intentional scenarios. It reflects an additional Vulnerability category of "Very Low" based on the vulnerability criteria in Table 4-7.

Table 5-2
Vulnerability & Consequence Matrix

Consequence					
	High (3)	Document (3)	Consider (6)	Mitigate (9)	Mitigate (12)
	Medium (2)	Document (2)	Document (4)	Consider (6)	Mitigate (8)
	Low (1)	Document (1)	Document (2)	Document (3)	Document (4)
		Very Low (1)	**Low (2)**	**Medium (3)**	**High (4)**
		Vulnerability			

Similar to Table 5-1(a) above, the levels of acceptable risk/ desired actions for the "Intentional Acts Scenarios" at MARSEC Level 1 are calculated by multiplying the

Consequence Score by the Vulnerability Score, and the results are displayed in Table 5-2(a) below.

Table 5-2(a)
Risk Score Categories "Intentional Scenarios"

Recommended Action*	Risk Scores
Document	1-4
Consider	5-6
Mitigate	7-12

*The meanings of "Document", "Consider", and "Mitigate are the same as those given in Section 5.2.1 above.

The Risk Score for each scenario increases proportionately as the threat level increases. As shown in the "What If Tables for Security/Intentional Act Scenarios" (Appendix F), the Threat Level (1, 2, 3) is included in calculating the Risk Score for each What-if Scenario at each MARSEC Level; however, the level of acceptable risk does NOT increase as the MARSEC level increases. The Risk Score deemed acceptable at MARSEC 1 remains the preferred level of Risk at all MARSEC Levels. Therefore, additional security mitigation measures should be implemented to keep the Risk Score at increasing MARSEC Levels at or below the Risk Score determined to be acceptable at MARSEC Level 1.

5.3 EXISTING RISK MITIGATION STRATEGIES/MEASURES

At present there are no operational guidelines specifically established for LNG ships transiting the Columbia River. If this facility is approved, it is recommended that such guidelines be developed and published in a COTP Portland LNG Operations Manual for the Columbia River, or Vessel Transit Management Plan, as was mentioned in the WSR for the Bradwood proposal. The guidelines would define the applicable policies and guidelines such as weather and sea condition limitations, vessel traffic management expectations and other mitigation measures for LNG ships to enter and operate in the Columbia River. The "Chesapeake Bay Liquefied Natural Gas (LNG)

Operations Manual" jointly developed and maintained by Sector Hampton Roads and Sector Baltimore is an excellent example of such a document.

It is recognized that there are already standard practices/risk mitigation methods in place that apply to commercial vessels, including LNG vessels, seeking entry into a U.S. port. These measures were not considered when developing the "unmitigated" Risk Scores in Appendices E & F if the measure would become a new requirement for the Coast Guard or other enforcement agency when LNG ships arrived to the Columbia River, but they were included along with other specific "new" measures in developing the "mitigated" Risk Scores at MARSEC 1.

5.3.1 Pre-Arrival

Requirements already exist in 33 CFR 160 for vessels (including LNG vessels), to submit Advanced Notices of Arrival (ANOA) 96 hours prior to arrival in a U.S. Port. Within the ANOA, the vessel must provide information on the vessel, voyage information (last five ports visited), cargo information, crew member and passenger information, operational condition of equipment specified in 33 CFR 164, date of issuance of Certificate of Compliance, and date of issuance of International Ship Security Certificate (ISSC) with a declaration that the security plan is being implemented.

The COTP Portland will review the information in the ANOA and use risk based decision making tools to determine whether the LNG ship requires a USCG security boarding, safety examination, or other action prior to permitting entry into the Columbia River. If deemed appropriate, security and safety boardings will be conducted well offshore prior to embarkation of the pilot and prior to the ship being permitted entry into port.

5.3.2 Maritime Domain Awareness

The Coast Guard and other marine law enforcement agencies presently conduct routine operations that provide a level of maritime domain awareness (MDA). Having a good awareness of what "normal" activity is within the port is also an important mitigation measure since that will be a critical element of deterring and/or disrupting any

attempted attack. The following activities are being conducted routinely at MARSEC 1 in and around the Columbia River regardless of the development of LNG terminals in the river.

(A) HARBOR PATROLS

The Coast Guard conducts periodic, dedicated small boat harbor patrols of U.S. ports to maintain awareness of maritime activity with a view towards identifying suspicious activity. These harbor patrols are routinely conducted in the waters between the mouth of the Columbia River and Astoria.

(B) OPERATIONAL MISSIONS AND OTHER ROUTINE SMALL BOAT OPERATIONS

The Coast Guard and other marine law enforcement agencies, such as Washington State Fish and Game, Oregon State Police, and Clatsop County Police, operate routinely in the area of the proposed transit. While doing so, the crews are also maintaining an awareness of "normal" activity and are alert to suspicious activity.

(C) AIR PRESENCE

Coast Guard Group/Air Station conducts extensive routine flight operations with its HH60 helicopters on operational missions as well as dedicated air harbor patrols and coastal surveillance.

(D) REMOTE SURVEILLANCE

CG Station Cape Disappointment has a camera that observes the Columbia River Bar area. While intended for use as a safety measure to observe vessels crossing a potentially hazardous boating area, the camera also helps provide awareness of boating activity.

(E) AMERICA'S WATERWAY WATCH PROGRAM

An existing national system coordinated by the Coast Guard to publicize the need for awareness and reporting by the boating public and waterfront community of suspicious activity that might be related to terrorism. Construction of a LNG receiving

terminal within the river system will not change the program, but may certainly increase the interest and importance of the program.

5.4 PROPOSED RISK MITIGATION MEASURES

5.4.1 Accidental/Safety Scenarios

As indicated in the "Summary Table of Accidental Scenarios with Mitigation Measures" (Appendix G), the only accidental scenarios with Risk Scores in the "Mitigate" or "Consider" ranges are:

- "Grounding on the North Jetty Inside the Mouth of the River (Summer)" (6-Mitigate), and
- High Speed Collision at Track Leg 4 during Buoy 10 Season" (3 - Consider)

5.4.1.1 "Grounding on the North Jetty inside the Mouth of the River in the Summer" - (Mitigate)

The Sandia Report states that a grounding of an LNG vessel is not expected to result in the breach of the vessel's cargo tanks unless the grounding results in a penetration of at least three meters.[55] In 1979 the LNG ship, EL PASO PAUL KAYSER, ran hard aground on a rock pinnacle at a speed of 14 knots off Algeciras, Spain, near Gibraltar. A great deal of structural damage was done, but the cargo tanks remained intact and no cargo was lost.

Halcrow took the conservative approach and assumed that an accidental grounding in the vicinity of the North Jetty could result in the breach of one or more of the vessel's cargo tanks if the vessel remained aground and heavy swell conditions on the Bar caused the vessel to pound extensively and eventually fail. For this assessment we assumed that the vessel ran aground right at the jetty so that during the summer

[55] Sandia Report, SAND2004-6258. Tables #9 & # 12 Pages 44 & 47.

high tourist season we would have a Zone 1 overlapping a medium population density in the State Park.

Probability Score:

Three mitigation measures are suggested to reduce the Probability Score for this scenario:

1. Policy or guidance should be developed outlining acceptable weather parameters for loaded LNG vessels seeking to enter the Columbia River and transit up to the Oregon LNG Terminal. The CH2M Hill/Oregon LNG Simulation Report dated 01/03/2008 (Appendix T) conducted at the Pacific Maritime Institute by the Columbia River Pilots, recommends:[56]

   (i) Bar Crossing Inbound – Sixteen foot waves and twenty five knots of wind

   (ii) River transit – 25 knots of wind

   (Recommendation 7.3.2 (B)(2))

2. Policy or guidance should be developed requiring two commercial tugs to meet the inbound ship in the area of the Columbia River Bar in order to provide assistance if needed to prevent an incident or respond immediately to remove the ship from danger or stabilize the situation. The requirement for two tugs is reinforced by the permissible weather conditions discussed above which are based on two tugs being available to provide assistance. (*Recommendation 7.3.2 (B)(6))*

3. All Bar Pilots who will pilot the larger LNG vessels should be required to complete ship handling training for the new class of vessel. *(Recommendation 7.3.2 (B)(1))*

Although the mitigation methods discussed above reduce the Probability Score to a “1”, the mitigated Risk Score is still a “3” which is classed as “Consider”. To further

reduce the mitigated Risk Score to a "Document" we need to evaluate methods of reducing the Consequence Score. The Consequence Score of "3" is driven by the fact that the Zone of Concern #1 overlaps a small portion of the southwest corner of the Park which during the summer months was treated as a medium density population area.

Consequence Score:

Two mitigations that could reduce the Consequence Scores of this scenario are:

1. Limit loaded LNG vessel transits to night time only (beginning late afternoon or early evening) during the summer tourist season (June – September). The number of visitors in the Park is greatly reduced in the evening and the visitors are clustered in the camp site areas north of the Zone 1 and Zone 2 overlaps. This mitigation method would reduce the Consequence Score from a "3" to a "1" (Zone 1 over a low population area). *(Recommendation 7.3.2 (B)(8))*

2. Establish a warning system in the Cape Disappointment State Park which would warn visitors/employees of an LNG incident in the vicinity of the Park. This system should direct all visitors and Park employees to immediately leave the breakwater beach area of the Park and either depart the Park or muster in the North Head camp ground area. By directing the Park visitors and employees to leave the Park or muster in the North Head campground area, the areas of the Park overlapped by Zone 1 and Zone 2 become low population areas and the Consequence Score (Zone 1 and Zone 2 over low population area) become a "1". *(Recommendation 7.3.2 (B) (20))*

The final mitigated Risk Score for this scenario become a "1".

[56] Oregon LNG Simulation Report, Final 01/03/2008. Pages 5-7.

5.4.1.2 High Speed Collision on Track Leg 4 During the Busiest Fishing Season (Consider)

The unmitigated Risk Score for the accidental high speed collision scenario is classified as “Consider”,”3”, for this leg of the transit. The “Consider” score results from a Consequence Score of “3” which in turn is driven by the Buoy 10 area being treated as a medium density population area during the three busiest fishing seasons (June – Sept).

Probability Score:

Although the Probability Score is “Low”, “1”, based on Pilot history, four mitigation measures are recommended to reduce the Probability of such an accident:

1. All Bar Pilots who will pilot the larger LNG vessels should be required to complete ship handling training for the new class of vessel. *(Recommendation 7.3.2 (B)(1))*

2. Policy or guidance should be developed requiring two commercial tugs to meet the inbound ship in the area of the Columbia River Bar in order to provide assistance if needed to prevent an incident or respond immediately to remove the ship from danger or stabilize the situation. The requirement for two tugs is reinforced by the permissible weather conditions discussed above which are based on two tugs being available to provide assistance. *(Recommendation 7.3.2 (B)(6))*

3. A traffic management scheme requiring one way traffic along the Desdemona Channel from Buoy 8 to the terminal pier should be established. *(Recommendation 7.3.2 (B)(5))*

4. Policy or guidance should be developed outlining acceptable weather/visibility restrictions along the transit route from the Bar to the terminal. The Oregon

LNG Simulation Report dated 01/03/2008 (Appendix T) conducted at the Pacific Maritime Institute by the Columbia River Pilots, recommends:[57]

(i) River transit – 25 knots of wind. *(Recommendation 7.3.2 (B)(2))*

Consequence Score:

As noted above, it is the Consequence Score that is driving the High Speed Collision scenario Risk Score. The high Consequence Score is being driven by the seasonal medium density population during the busiest fishing seasons (June – Sept) which results in a Consequence Score of "3", Zone 1 over a Medium density population. In order to reduce the Consequence Score for the inbound transit during the busiest fishing seasons (approximately June – Sept) policy or guidance should be established mandating night transits (beginning late afternoon or early evening) for all loaded LNG vessels during these months. The boating population is drastically reduced during the evening hours reducing the population density on this track leg from a "medium" to a "low", which reduces the Consequence Score from "3" to a "1", which lowers the mitigated Risk Score to a "1". This policy should be enforced every year during the busiest portion of the Buoy "10" Season and should be evaluated each year for the other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead. *(Recommendation 7.3.2(B)(8)*

5.4.1.3 Ship Breaking Loose from Dock Due to Surge from Ship, Weather, or Tsunami (N/A)

These three scenarios all received a Risk Score and Consequence Score of "N/A" because these scenarios are not expected to result in a large release of the LNG cargo. If a vessel did break free from the dock, in the worst case it would drift aground. As discussed in Section 5.4.1.1, the Sandia Report states that the grounding of an LNG vessel is not expected to result in the breach of the vessel's cargo tanks unless the

[57] Oregon LNG Simulation Report, Final 01/03/2008. Pages 5-7.

grounding results in a penetration of at least three meters. [58] They also received a probability score of "1".

In Section 5.4.1.1 we took a very conservative approach and assumed a worst case scenario in which the vessel not only ran aground but then remained aground on the rocks of the jetty in the heavy swell of the Bar until the cargo tanks failed. This would not be an appropriate scenario in the vicinity of the proposed LNG terminal as there is no breaking surf or large rock jetties in the area.

However, the participants at the Risk Assessment Work Shop felt that measures should be in place to address the occurrence of sudden heavy winds.

Probability Score:

Two mitigation measures are recommended:

1. To reduce the risk of high winds causing an accident with cargo transfer connections, policy or guidance should be developed to establish wind speed limits at which point cargo transfer operations should be halted. The "Chesapeake Bay Liquefied Natural Gas (LNG) Operations Plan" requires transfer operations to be halted, "… if the sustained wind speed is greater than 30 knots." As discussed in Section 3.1.2, the proposed facility's mooring rating is 56 knots so Baltimore's 30 knot criteria works well with regard to the terminal's mooring rating. *(Recommendation 7.3.2(D)(2))*

2. It is recommended that two or three of the facility's tugs remain on immediate stand by whenever an LNG ship is moored and offloading. The number of tugs required would be dependent on the size of the LNG vessel at the pier. The tugs should be available to get the ship away from the dock in an emergency and they should be available to hold the ship on the dock if the wind suddenly picks up. *(Recommendation 7.3.2(C)(8))*

[58] Sandia Report Tables #9 & # 12 Pages 44 & 47.

5.4.2 Intentional/Security Scenarios (Underway)

As indicated in the "Summary Table of Intentional Scenarios with Mitigation Measures @ MARSEC 1, 2 & 3", (Appendix H, I & J), almost all of the Intentional scenarios have unmitigated Risk Scores in the "Mitigate" or "Consider" ranges.

5.4.2.1 Small Boat Attack ("USS Cole type")

As indicated in the "Summary Tables of Intentional Scenarios" (Appendix H), there were two (2) track legs with unmitigated Risk Scores in the "Mitigate" category:

1. Seasonal along track legs 3, 4, 5 & 6 during the heaviest fishing seasons (June – Sept) (Mitigate)

2. Seasonal along track Leg 6 between Hammond Marina and Tansy Points (June – Sept) (Mitigate)

The high unmitigated Risk Scores were driven primarily by the Vulnerability scores of "4" for both scenarios and the Consequence score of "3" for track legs 3-6 during the busiest fishing seasons (June – Sept) and the Consequence score of "2" for track leg 6 during the busy summer tourist season.

Vulnerability Score:

In order to reduce the Vulnerability Score from the small boat threat in both scenarios it is necessary to keep the small boats away from the inbound LNG vessels. That is best accomplished by establishing/enforcing a security zone around inbound loaded LNG vessels.

At MARSEC 1, it is recommended that a 500 yards security zone be established and enforced around all inbound loaded LNG vessels. Enforcement of the security zone should permit vessels to enter the 500 yard zone to within 100 yards of an arriving LNG vessel if the other vessel maintains a steady course at a slow speed, just enough to maintain steerageway, or is stopped or anchored. Allowing other vessels to approach to within 100 yards of an LNG vessel, if they are moving very slowly or anchored, addresses the need to minimize impacts on other waterway users,

particularly fishermen, during low threat conditions (MARSEC 1). This policy is consistent with the current COTP Portland regulations in 33CFR165.1318 for security zones around cruise ships transiting the Columbia River. It is also consistent with the Bradwood Landing WSR Security Zone recommendations.[59] Establishment of these flexible security zones would reduce the Vulnerability Score at MARSEC Level 1 from a "4" to a "3".

To enforce this security zone at MARSEC 1, a minimum of two "armed" escort boats is recommended. At this low threat level, the enforcement effort is primarily a deterrence presence. Therefore, the boats/crew should be equipped with a minimum of small arms and the crew should have a recognized law enforcement authority able to enforce the federal security zone. The boats should be in the size range of 20-30 feet long, capable of operating in sea conditions of up to 6 feet, with a speed capability of at least 25 kts, and equipped with an enclosed cabin to enable the boats to operate in inclement weather and low temperatures.

At MARSEC 2, it is recommended that the security zone be increased to a firm 500 yards without the provision for vessels to enter the zone. That provides more distance to intercept an incoming small boat threat and keeps boats outside of the effective ranges of most stand-off weapons. To effectively enforce this zone when there is a raised threat level requires a minimum of 3 escort boats and preferably 4. At MARSEC 2, at least two of the escort boats should be equipped with an adequate "response" capability of mounted crew-serve weapons (machine guns) that will effectively stop an inbound small boat. It is also recommended that air and surface patrols of area by Coast Guard and other law enforcement agencies be increased. This mitigation measure reduces the Vulnerability Score to a "2".

At MARSEC Level 3, it is recommended that the security zone be extended even further. Declaration/implementation of MARSEC 3 means that a specific/imminent threat has been identified. The vessel management option of closing the port to LNG ship traffic is always an option to be considered by the COTP. That action would

[59] "Waterway Suitability Report for Bradwood Landing LNG" dated February 28, 2007. Page 1.

eliminate the risk altogether and may be the best option depending on the situation. However, for the purpose of this risk assessment the assumption was made that LNG vessels would be permitted entry under strict security provisions. Therefore, it was deemed appropriate to increase the security zone size to 1000 yards to permit more response time for the escort boats and escort helicopters to react to an incoming threat. When using the term “1000 yard security zone”, it is really intended to be 1000 yards in front and behind and closer to 500 yards on either side due to proximity of land to the west and shoal water to the east of the track. To adequately enforce a 1000 yard security zone would take a minimum of 4 boats. Similarly, at MARSEC 3 it is considered appropriate for an armed helicopter escort to work in coordination with the escort boats. Establishment of an expanded security zone, around an inbound loaded LNG vessels, would further reduce the Vulnerability Score from a “2” to a “1”.

If the Columbia River is at MARSEC 3, it would be reasonable to assume that support from a Coast Guard Maritime Safety and Security Team (MSST) could be arranged. If so, in addition to escort boats, another mitigation measure to enforce the security zone is to provide personnel with portable machine gun mounts to embark and be installed for defense on the inbound LNG vessel. The general practice, as used by Coast Guard Port Security Units, is to have an established procedure that if an attacking small boat does evade the escort boats and is heading for the ship, the escort boats clear out of the way so that fire is directed from the ship at the incoming boat.

The additional security precautions required at MARSEC 3 will necessarily disrupt other waterway users, but it should be recognized that an increase to MARSEC 3 is not expected to occur very often, if at all. The transit is relatively short and the time to conduct the transit only a couple hours. The COTP and Bar Pilots should be able to orchestrate the time of transit to minimize disruptions and help mitigate vulnerability. If MARSEC 3 is declared and if it is deemed necessary to allow entry of these ships to port, the situation will be extremely serious and it is expected that the waterway users should understand.

At MARSEC 3 coordination with the local harbormasters and other law enforcement agencies will be critical. The marinas down stream of the Astoria-Megler

Bridge should be closed to outgoing small boat traffic one (1) hour prior to an LNG ship's arrival at the Bar.

As reflected in the work sheets in Appendix F, the requirements for the scenarios in both areas could be considered seasonal. The Buoy 10 season and in some cases the Sturgeon Fishing and Spring Salmon seasons drive the boating density and the summer tourism drives an increase in population density from June through September in Warrenton and the state parks. Therefore the Consequence Scores and the Risk Scores for the non-summer months are reduced. However, it is recommended that the security zones be enforced year round to maintain proficiency and establish the "expectation" of the practice by the boating public rather than an "on again-off again" approach that will create confusion and possibly resentment.

Similarly, to establish a consistency in practices/expectations between all of the various agencies and organizations that may be involved in providing security, security zone enforcement should normally begin somewhere between Buoys 8 and 10 when the LNG vessels will slow down to tether with one of the escort tugs. The exact start location may vary somewhat based on where the escort tugs are able to meet the LNG vessels and commence their escort. The ships will be traveling at a higher rate of speed along the Entrance Range Channel and through the right turn onto the Sand Island Range Channel to ensure the ship maintains good steerageway. If the weather/sea conditions are not conducive to the tugs "hooking" up to the ship in the Bar they may decide to meet the ship closer to Buoy 10 or 14. This is also acceptable for the escorts adhering to the rationale that if the sea conditions are too rough for the tugs with professional seamen aboard to work alongside the ship, it will also deter others from bringing a small boat alongside to inflict damage. While it is acknowledged that the motivation for bringing the boat alongside is different and safety is not an issue for a terrorist, they will also want to be sure that their mission is a success. If they cannot bring the boat alongside and hold it snugly alongside until the explosives can be detonated, the resulting blast may not achieve their desired results. It is considered probable that the terrorists will wait for better weather themselves to ensure success.

Broader measures complement the security effort by establishing awareness of boating/vessel activity in the area so that escort boats are prepared to respond if

needed to suspicious activity. Therefore, a routine effort to maintain MDA using surface and air harbor patrols contribute to the specific escort effort. Harbor patrols should be conducted periodically during MARSEC 1. As the threat increases, the surveillance patrol efforts should become more frequent and more directed. At MARSEC 2, the frequency should increase and patrols of the transit area should be conducted either by surface or air means just prior to the ship entering port. At MARSEC 3, the area patrols should be even more frequent (daily) and a specific air escort should be conducted working in conjunction with the boat escort. If the threat that caused the increase to MARSEC 3 is directed at LNG, the air escort should be armed and capable of responding to a boat threat.

The ongoing Coast Guard outreach program (Americas Waterway Watch program) to the waterfront community also contributes to maintaining awareness and alerting to activities within the Columbia River that will provide information of any suspicious activities. Public awareness efforts by the Coast Guard and Coast Guard Auxiliary should increase if MARSEC increases. Contributions to MDA are also recognized by the marine activities of the other law enforcement agencies operating in the area, such as the Washington Department of Fish and Wildlife, the Oregon State Police Department, and the Clatsop County Police Department.

Consequence Score:

In order to reduce the Consequence Score for the inbound transit through the busiest fishing seasons (approximately June – Sept) policy or guidance should be established mandating night transits (beginning late afternoon or early evening) for all loaded LNG vessels during this time. The boating population is drastically reduced during the late afternoon evening hours reducing the population density on this track leg from a “medium” to a “low” and would reduce the Consequence Score from “3” to a “1”. This policy should be enforced every year for the busiest periods of the Buoy “10“ season and should be evaluated each year for the other two major fishing seasons - Sport Sturgeon and Spring Chinook/Steelhead.

Summary of Proposed Risk Mitigation Measures for the "Small Boat Attack" Scenario:

Halcrow recommends the following mitigation measures to reduce the risk of the "Small Boat Attack" scenario:

a. Recommend establishment of a moving security zone around inbound LNG ships from the CR Buoy to the dock as follows:

- MARSEC 1 – 500 yards with provision for vessels traveling at speed reduced to bare steerageway or stopped/anchored to enter the zone to within 100 yards of ship.

- MARSEC 2 – 500 yards without exception.

- MARSEC 3 – 1000 yards ahead of ship and 500yards on the sides and astern. *(Recommendation 7.3.2 (B)(9))*

b. Recommend enforcement of the established zones around inbound ships with the following:

- MARSEC 1 – Minimum of two (2) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug.

- MARSEC 2 – Minimum of three (3) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug.

- MARSEC 3 – Minimum of four (4) armed boats beginning between Buoy 6 and Buoy 14, and armed helicopter escort. (*Recommendation 7.3.2 (B)(10))*

- To establish a consistency in practice/expectations between all of the various agencies and organizations that may be involved in providing security, security zone enforcement should normally begin somewhere between Buoys 8 & 10 when the LNG vessel will slow down to tether with one of the escort

tugs. The exact start location may vary somewhat based on where the escort tugs are able to meet the LNG vessel and commence their escort. *(Recommendation 7.3.2 (B)(11))*

c. Policy or guidance should be developed establishing a policy mandating night (beginning late afternoon or early evening) transits for all loaded LNG vessels during the three busiest fishing seasons (approximately June – Sept). The Buoy "10" salmon season in August early September is large enough to probably require enforcement of the night time transit requirement each year. The other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead should be evaluated each year to determine whether or not enforcement of the night time transit requirement is required. *(Recommendation 7.3.2 (B)(8))*

d. At MARSEC 3, marinas down river of the Astoria-Megler Bridge should be closed to outgoing small boat traffic one (1) hour prior to an LNG vessel's arrival at the Bar. *(Recommendation 7.3.2 (B)(17))*

e. At MARSEC 3, POSCON Teams should ride the inbound vessel with crew served weapons, machine guns, mounted as a point defense. *(Recommendation 7.3.2 (B)(14))*

f. At MARSEC 3 it is considered appropriate for an armed helicopter escort to work in coordination with the escort boats. *(Recommendation 7.3.2 (B12))*

5.4.2.2 Ship Ramming

There are two (2) "Ship Ramming Scenarios" with unmitigated Risk Scores in the "Mitigate" or "Consider" categories:

1. Seasonal along track legs 3, 4, 5 & 6 during the heaviest fishing seasons (June – Sept) - (Mitigate)

2. Seasonal along track leg 6 & 7 between Hammond Marina and Tansy Point (June – Sept) (Consider)

(Note: The threat of a ship collision that results in a cargo tank breach is addressed three times in this Waterway Suitability Assessment (WSA); the accidental collision, the intentional ramming of a large commercial vessel into a loaded inbound LNG vessel; and the hijacking scenario where terrorists seize control of an LNG vessel and use it to ram another large commercial vessel.)

The high unmitigated Risk Scores were driven by Vulnerability Scores of "3" for both scenarios and Consequence Scores of "3" for track legs 3-6 during the busiest fishing seasons (June – Sept) with Zone 1 overlapping a medium population density area caused by the tremendous number of fishing vessels in a small area and the Consequence Score of "2" for track leg 6 & 7 between Hammond and Tansy Points based on Zone 2 overlapping a medium density population area (seasonal).

Vulnerability Score:

The Vulnerability Scores for both of these track legs can be mitigated by establishing a vessel management policy that prohibits meeting situations between loaded LNG ships and other ships greater than 50,000 GT. It is recommended that a one-way ship traffic policy be implemented when loaded LNG ships are inbound from the Sand Island Range Channel (starting at Buoy 8) until they are out of the ship channel and being pushed toward the dock.

At MARSEC 1, it is recommended that outbound ships be held upriver of the Astoria-Megler Bridge until the inbound LNG ship is in the turning basin. The distance upriver is probably not sufficient to react if a last minute hijacking occurred on the down bound ship if the LNG ship is in the Upper Desdemona Shoal Channel. However, the policy is a very effective deterrent for MARSEC 1, since it makes the scenario, which is already difficult to plan/execute, much more difficult. This reduces the Vulnerability Score from a "3" to a "2" for both segments and results in a mitigated Risk Score of "4" (Document) for Track leg 6 & 7 between Hammond Marina and Tansy Point.

At MARSEC 2 and 3, the Risk Scores rose due to the increased threat and the distance upriver was considered insufficient to react, given the increased threat. At MARSEC 2 and 3 therefore, it is recommended that the down bound ships be held

further upriver, such as near Rice Island, until the LNG ship is in the Upper Desdemona Shoal Channel where it should be able to get around and out of the way safely if a problem occurs on the down bound ship. This reduces the Vulnerability Scores at MARSEC Levels 2 & 3 to "1".

Overtaking situations between ships will probably not provide enough relative speed distance or a sufficient angle to create a breach in a cargo tank, but should also be prohibited as mentioned above for one-way traffic. If the established security zone is adhered to, large commercial ships will not be able to pass LNG ships in much of Desdemona Channel without both ships moving to the edges of the navigational channels. Not only does that increase risk of a navigational error but permitting ships to pass in the channels would cause confusion/distract escort boats enforcing the security zones It would be prudent simply to make a policy prohibiting overtaking as well as meeting situations for the larger commercial ships (over 50,000GT). The transit to the proposed Oregon LNG Terminal site is not long and overtaking another inbound ship would not save enough time to warrant to additional risk incurred.

To prevent a large vessel from ramming a moored LNG vessel, policy or guidance should be developed requiring at least one of the Oregon LNG Terminal tugs to escort all up bound and down bound vessels of over 50,000 GT between Buoys 27 & 31. A second tug shall be in immediate standby in the terminal basin

Positive control (POSCON) boardings are typically considered a mitigation measure for inbound transits. However, in this scenario the threat is from outbound vessels intentionally ramming an inbound loaded LNG vessel. The POSCON team would ensure that a downbound vessel does not ignore the COTP order to remain the specified distance upriver until an arriving LNG vessel is safely moored. The POSCON team would serve as the enforcement arm, similar to the vessel escorts enforcing security zones. Therefore, periodic POSCON boardings of downbound vessels should be implemented to protect against the intentional ramming scenario. The frequency of these POSCON boardings should be significantly increased at the higher MARSEC levels. If a series of vessels are downbound the POSCON team should be embarked on the lead outbound ship.

POSCON boardings should also be conducted on transiting vessels of over 50,000 GT whenever a loaded LNG vessel is moored at the Terminal. The frequency of the POSCON boardings should increase with increases in MARSEC Levels.

Consequence Score:

Implementing the proposed Vulnerability mitigation measures reduces the Vulnerability Scores from a "3" to a "2" and reduces the mitigated Risk Score for the track leg between the Hammond Marina and Tansy Point to a "4" (Document). However, the "Seasonal Heaviest Fishing Seasons along track legs 4, 5 & 6 (June – Sept)" scenario would still have a Risk Score of "6" because of the Consequence Score of "3". The Consequence Score is a "3" because Zone 1 would overlap a large number of boaters during the highest boating seasons.

As discussed in Section 5.4.2.1 above, policies or procedures should be developed mandating night time (beginning late afternoon or early evening) transits for all loaded LNG vessels during the busiest fishing seasons (approximately June – Sept). The boating population is drastically reduced during the evening hours reducing the population density on this track leg from a "medium" to a "low" which reduces the "Consequence" score from a "3" to a "1". The final Risk Score for this scenario is a "2" – Document.

Summary of Proposed Risk Mitigation Measures for the "Ship Ramming" Scenario:

Halcrow recommends implementation of the following vessel management policies to reduce the risk of the "Ship Ramming" scenario:

a. Policy or guidance should be developed establishing mandatory one-way commercial ship traffic on the Desdemona Shoal Channel from Buoy 8 to the proposed Oregon LNG Terminal whenever a loaded LNG ship is inbound. At MARSEC 1 all outbound traffic should be held upriver of the Astoria-Megler Bridge until the inbound LNG Vessel is in the turning basin. At MARSEC 2 & 3 all outbound vessels should be held further up river, such as north of Rice Island.

Inbound commercial vessels should not be allowed to overtake transiting LNG vessels. *(Recommendation 7.3.2 (B)(5))*

b. Periodic "Positive Control" (POSCON) boardings should be conducted on down bound vessels of over 50,000 GT whenever a loaded LNG vessel is transiting the Columbia River. The frequency of the POSCON boardings should increase with increases in MARSEC Levels. If a series of vessels are down bound the POSCON team should be embarked on the lead outbound ship *(Recommendation 7.3.2 (B)(13))*

c. Periodic "Positive Control" (POSCON) boardings should be conducted on transiting vessels of over 50,000 GT whenever a loaded LNG vessel is moored at the Terminal. The frequency of the POSCON boardings should increase with increases in MARSEC Levels. *(Recommendation 7.3.2 (B)(18))*

d. Policy or guidance should be developed requiring at least one of the Oregon LNG Terminal tugs to escort all up bound and down bound vessels of over 50,000 GT between Buoys 27 & 31. A second tug shall be in immediate standby in the terminal basin. *(Recommendation 7.3.2 (C)(10))*

e. Policy or guidance should be established mandating night time transits (beginning in the late afternoon or early evening) for all loaded LNG vessels during the three busiest fishing seasons (approximately June – Sept). The Buoy "10" salmon season in August early September is large enough to require enforcement of the night time transit requirement each year. The night transit policy should be enforced every year for the busiest portions of the Buoy "10" Season and should be evaluated each year for the other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead to determine whether or not enforcement of the night time transit requirement is required. *(Recommendation 7.3.2 (B)(8))*

5.4.2.3 Stand-Off Weapon Fired from a Vessel

There are two "Stand-Off Weapon Scenarios" with unmitigated Risk Scores in the "Mitigate" or "Consider" categories. The Risk Scores for this scenario again focus attention on:

1. Seasonal along track legs 3, 4, 5 &6 during the heaviest fishing seasons (June – Sept) (Mitigate)

2. Seasonal along track leg 6: track leg 6 between Hammond Marina and Tansy Point (June – Sept) (Mitigate)

The high unmitigated Risk Scores were driven by the Vulnerability Score of "4" for both scenarios. The Consequence Score for the seasonal fishing is a "3" because Zone 1 would overlap a large number of boaters during the highest boating seasons. The Consequence Score for the Hammond Marina and Tansy Point areas was determined to be a "2" based on a Zone 2 overlapping a medium density population area (summer).

Vulnerability Score:

As in the "USS Cole" type attack scenario, the most effective method of reducing an LNG vessel's vulnerability to a stand off weapon fired from another vessel is to keep other vessels away from inbound loaded LNG vessels. Therefore it is recommended that a moving security zones be established around inbound LNG ships from the CR Buoy to the dock as described in the "Small Boat Attack" scenario in Section 5.4.2.1 above. Enforcement of the security zone should increase with increasing MARSEC Levels.

At MARSEC Level 3, the small boat vessel escort should be supported with an air escort and all marinas down river of the Astoria-Megler Bridge should be closed to outgoing small boat traffic one hour prior to an LNG vessel arriving at the Bar.

This reduces the Vulnerability Score from "4" to "3" for MARSEC 1, from "3" to "2" at MARSEC 2 and from "2" to "1" at MARSEC 3.

Consequence Score:

The Consequence Score, "3" for track legs 3-6 during the heaviest boating seasons (June – Sept) is based on Zone 1 overlap of a medium density population. The most effective mitigation measure to reduce the Consequence Score along these legs is for policy or guidance to be developed mandating night transits (beginning late afternoon or early evening) for all loaded LNG vessels during the busiest fishing seasons (approximately June – Sept). This reduces the Consequence Score from a "3" to a "1" for track legs 3-6 during the busy fishing seasons (June – Sept). The Consequence Score for the track legs between Hammond Marina and Tansy Point remains a "2" with Zone 2 overlapping a medium population density during the summer months.

Summary of Proposed Risk Mitigation Measures for the "Stand-Off Weapon Fired from a Vessel" Scenario:

An attack by a small boat using a stand-off weapon requires much the same mitigation measures as those defined in the "USS Cole type small boat scenario". Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Stand Off Weapon" scenario:

a. Recommend establishment of a moving security zone around inbound LNG ships from the CR Buoy to the dock as follows:

- MARSEC 1 – 500 yards with provision for vessels traveling at speed reduced to bare steerageway or stopped/anchored to enter the zone to within 100 yards of ship.

- MARSEC 2 – 500 yards without exception.

- MARSEC 3 – 1000 yards ahead of ship and 500yards on the sides and astern. *(Recommendation 7.3.2 (B)(9))*

b. Recommend enforcement of the established zones around inbound ships with the following:

- MARSEC 1 – Minimum of two (2) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug.

- MARSEC 2 – Minimum of three (3) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug.

- MARSEC 3 – Minimum of four (4) armed boats beginning between Buoy 6 and Buoy 14, and armed helicopter escort. Coast Guard or other law enforcement personnel embarked on inbound ship with portable crew served weapons for defense. *(Recommendation 7.3.2 (B)(10))*

- To establish a consistency in practice/expectations between all of the various agencies and organizations that may be involved in providing security, security zone enforcement should normally begin somewhere between Buoys 8 & 10 when the LNG vessel will slow down to tether with one of the escort tugs. The exact start location may vary somewhat based on where the escort tugs are able to meet the LNG vessel and commence their escort. *(Recommendation 7.3.2 (B)(11))*

c. Policy or guidance should be developed mandating night transits (beginning in the late afternoon or early evening) for all loaded LNG vessels during the three busiest fishing seasons (approximately June – Sept). The busiest portions of the Buoy "10" salmon season in August early September is large enough to require enforcement of the night time transit requirement each year. The other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead should be evaluated each year to determine whether or not enforcement of the night time transit requirement is required. *(Recommendation 7.3.2 (B)(8))*

d. It is recommend that at MARSEC Level 3 the small boat vessel escort should be supported with an air escort. *(Recommendation 7.3.2 (B) 12))*

e. At MARSEC Level 3 all marinas down river of the Astoria-Megler Bridge should be closed to outgoing small boat traffic one hour prior to an LNG vessel arriving at the Bar. *(Recommendation 7.3.2 (B) 17))*

5.4.2.4 Stand-off Weapon Fired from Shore

The Risk Scores for this scenario focus attention on the two locations a stand-off weapon could be launched from:

- The Hammond Marina Point and Tansy Point (Mitigate)

The high unmitigated Risk Scores were driven by the Vulnerability Score of "2" for Hammond Point and a "4" for Tansy Point. The Consequence Score for both Hammond Marina and Tansy Point is a "2" because Zone 2 would overlap a medium population density area (summer).

As discussed in Section 4.5.7(B) above, only the lighter shoulder launched weapons were considered viable means of attack in this report. The maximum effective range used was 500 meters. Based on that premise, there were two locations on shore that were deemed feasible: the point of land at Hammond Marina Basin and the Warrenton Fiber property on Tansy Point.

The Hammond Marina Basin is right at the outer range of a shoulder launched weapon and was given a Vulnerability Score of "2". The resulting unmitigated Risk Score is "4". A transiting LNG vessel would be most vulnerable as it passed Tansy Point because it is well within range of a weapon fired from shore. This results in a Vulnerability Score of "4". The Consequence Score of "2" was based on a Zone 2 overlap of the City of Warrenton which is a seasonal medium density population. The resulting unmitigated Risk Score is "8".

Vulnerability Score:

The most effective mitigation measure to reduce an LNG vessel's vulnerability to a stand-off weapon attack from shore is to provide police presence along the shore to detect and deter attempts to launch weapons at a passing LNG vessel. As per discussions at the Risk Assessment Work Shop, the Warrenton police should be contracted to sweep the Warrenton waterfront area prior to the ship's arrival off the Hammond Marina and Tansy Point to ensure no unusual activity is ongoing. At

MARSEC 1, it is simply intended to do a sweep by the area prior to the ship approaching the points of land to ensure there are no suspicious people in the area.

At MARSEC 2 and 3, the police presence should be increased to a more continuous presence so that the area is observed while the ship approaches and passes the point to ensure security on the shore side. The escort boats enforcing the moving security zone around the inbound LNG vessel would also serve to detect and deter attacks from shore side. The police officers on patrol and the crew of the escort boats must be able to communicate effectively with each other.

These mitigation measures reduce the Vulnerability Score from a "4" to "1" for MARSEC Level 1, 2 & 3. The final mitigated Risk Scores are "2", "4" and "6" at MARSEC Levels 1, 2 & 3 respectively.

Consequence Score:

No mitigation measures were identified to reduce the Consequence Score in this scenario.

Summary of Proposed Risk Mitigation Measures for the "Stand-Off Weapon Fired from Shore" Scenario:

Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Stand Off Weapon Fired from Shore" scenario:

a. Recommend a shore side law enforcement patrol in vicinity of Tansy Point and Hammond Marina as follows:

- MARSEC 1 – Sweep of areas in advance of ship transit past locations.
- MARSEC 2 & 3 – Presence at each location while the ship transits past. *(Recommendation 7.3.2(B)(18))*

b. Recommend establishment of a moving security zone around inbound LNG ships from the CR Buoy to the dock as follows:

- MARSEC 1 – 500 yards with provision for vessels traveling at speed reduced to bare steerageway or stopped/anchored to enter the zone to within 100 yards of ship.

- MARSEC 2 – 500 yards without exception.

- MARSEC 3 – 1000 yards ahead of ship and 500yards on the sides and astern. *(Recommendation 7.3.2(B)(9))*

c. Recommend enforcement of the established zones around inbound ships with the following:

   - MARSEC 1 – Minimum of two (2) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug.

   - MARSEC 2 – Minimum of three (3) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug.

   - MARSEC 3 – Minimum of four (4) armed boats beginning between Buoy 6 and Buoy 14, and armed helicopter escort. Coast Guard or other law enforcement personnel embarked on inbound ship with portable crew served weapons for defense. *(Recommendation 7.3.2(B)(10))*

d. To establish a consistency in practice/expectations between all of the various agencies and organizations that may be involved in providing security, security zone enforcement should normally begin somewhere between Buoys 8 & 10 when the LNG vessel will slow down to tether with one of the escort tugs. The exact start location may vary somewhat based on where the escort tugs are able to meet the LNG vessel and commence their escort. *(Recommendation 7.3.2 (B)(11))*

e. Recommend that at MARSEC Level 3 the small boat vessel escort should be supported with an air escort. *(Recommendation 7.3.2 (B)(12))*

5.4.2.5 Small (General Aviation) Aircraft Attack

The Risk Scores for this scenario again focus attention on the busiest fishing areas along track legs 3-6 and track leg 6 transiting off the shore line of Warrenton from Hammond Marina to Tansy Point (summer). The Vulnerability Score for the entire transit was a "4". The Consequence Score for the seasonal fishing is a "3" because Zone 1 would overlap a large number of boaters during the highest boating seasons. The Consequence Score for the Hammond Marina and Tansy Point areas was determined to be a "2" based on a Zone 2 overlapping a medium density population area (seasonal).

Realistic, vulnerability mitigation measures for air threats on a maritime target are difficult. The preferred means of risk management for air threats is to identify and prevent terrorists before they take off. The responsibility for coordinating airport security awareness efforts on a national level lies with TSA. They have already instituted an airport watch program in partnership with the national organization, Aircraft Owners and Pilots Association (AOPA), distributing pamphlets to general aviation pilots and airports throughout the country with information on precautions that should be taken to improve security and what to look for and how to report suspicious activities. TSA has established a phone line to report suspicious activity and has also published recommended standards and practices in their publication, Security Guidelines for General Aviation Airports dated 2004. It is suggested in the TSA publication that the general aviation community at small airports is a small community that usually know each other or often related and that new people will be noticed and suspicious activity will be noticed.

Vulnerability Score:

The most effective method of reducing the Vulnerability Score in this scenario is through an aggressive security zone enforcement program. At MARSEC Level 1 the escorts would have limited impact on the Vulnerability Score as the crews are neither armed to shoot down an attacking small aircraft nor would the crew be likely to "pull the trigger" for fear that the aircraft was not hostile. Therefore, the Vulnerability Score was not reduced for MARSEC 1 and remains at a "4". However, at MARSEC 2 and 3 the

escort vessels should be armed with machine guns and the crew would be much more likely to "pull the trigger" at a heightened MARSEC Level. As the MARSEC increases the number and capability of the escort boats increases contributing to the reduction in the Vulnerability Score. Being very conservative, the Vulnerability Score was not improved with the additional escort boats at MARSEC 2. If the ship is permitted into port at MARSEC 3 and there is a potential air threat, the defenses would be prepared to act if an aircraft demonstrated hostile intent.

At MARSEC Level 3 an armed helicopter should support the security zone enforcement boats. The helicopter would be useful in detecting, intercepting, and attempting communications with an unknown aircraft in the area.

At MARSEC 3 an additional Vulnerability mitigation measure is to place a Coast Guard or other Law Enforcement Team armed with one or more machine guns aboard an arriving LNG vessel to provide "point source protection" capability. If an unknown/suspicious aircraft is clearly directed at the ship, machine gun fire directed from the ship would provide the final layer of active defense. The additional escort boats and crew served weapons resulted in a lower, "3", Vulnerability Score at MARSEC 3.

The proximity of commercial tugs to the ship places an impediment to a pilot trying to fly into the ship. While it will not block the entire ship, it will create an additional concern. The proximity of the tugs may also cause the pilot to hit the LNG vessel higher on its side rather than at the waterline significantly reducing the amount of LNG that would be released.

If ship entry approved at MARSEC 3, communications should be established between USCG and air traffic control of transit area (ATC Seattle) prior to ship entering the Columbia River and throughout the vessel's transit to ensure that no unusual aircraft activity is occurring at the time.

In addition, the "next best" mitigation for the risk of small aircraft attack is the hardness of the target. It is not expected that in most cases a small aircraft would be able to penetrate the double hull of an LNG ship to cause a cargo leak. It could

potentially penetrate the top of a tank which could leak cargo, but not in the amount modeled in the Sandia Report.

Consequence Score:

In order to reduce the Consequence Score for the inbound transit through the busiest fishing seasons (approximately June – Sept) policies or guidance should be established mandating night transits (beginning in the late afternoon or early evening) for all loaded LNG vessels during this time. The boating population is drastically reduced during the evening hours reducing the population density on this track leg from a "medium" to a "low" and would reduce the Consequence Score from "3" to a "1". This policy should be enforced every year during the busiest portions of the Buoy "10" season and should be evaluated each year for the other two major fishing seasons - Sport Sturgeon and Spring Chinook/Steelhead.

Summary of Proposed Risk Mitigation Measures for the "Small (General Aviation) Aircraft Attack" Scenario:

Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Small (General Aviation) Aircraft Attack" scenario:

a. Recommend establishment of a moving security zone around inbound LNG ships from the CR Buoy to the dock as follows:

   - MARSEC 1 – 500 yards with provision for vessels traveling at speed reduced to bare steerageway or stopped/anchored to enter the zone to within 100 yards of ship.

   - MARSEC 2 – 500 yards without exception.

   - MARSEC 3 – 1000 yards ahead of ship and 500yards on the sides and astern. *(Recommendation 7.3.2(B)(9))*

b. Recommend enforcement of the established zones around inbound ships with the following:

- MARSEC 1 – Minimum of two (2) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug.

- MARSEC 2 – Minimum of three (3) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug. The boats shall be armed with crew served weapons (machine guns).

- MARSEC 3 – Minimum of four (4) armed boats beginning between Buoy 6 and Buoy 14 armed with crew served weapons (machine guns) and armed helicopter escort. *(Recommendation 7.3.2(B)(10))*

c. Policy or guidance should be developed establishing mandating night transits (beginning in the late afternoon or early evening) for all loaded LNG vessels during the three busiest fishing seasons (approximately June – Sept). The busiest portion of the Buoy "10" salmon season in August early September is large enough to require enforcement of the night time transit requirement each year. The other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead should be evaluated each year to determine whether or not enforcement of the night time transit requirement is required. *(Recommendation 7.3.2(B)(8))*

d. If ship entry approved at MARSEC 3, communications should be established between USCG and air traffic control of transit area (ATC Seattle) prior to ship entering the Columbia River and throughout the vessel's transit to ensure that no unusual aircraft activity is occurring at the time. *(Recommendation 7.3.2 (B)(15))*

e. At MARSEC 3 an additional Vulnerability mitigation measure is to place a POSCON Team armed with one or more machine guns aboard an arriving LNG vessel to provide "point source protection" capability. If an unknown/suspicious aircraft is clearly directed at the ship, machine gun fire directed from the ship would provide the final layer of active defense. *(Recommendation 7.3.2 (B)(14))*

5.4.2.6 Commercial Aircraft Attack

During the Risk Assessment Workshop the consensus was that this scenario was not credible. For completeness we have completed the assessment here. At MARASEC 1 & 2 all of the track legs received Risk Scores of "4" or less (document) except for Track Legs 3-5 which received a Risk Score of "6" (Consider) due to a Consequence Score of "3" (seasonal) and Threat Level of 2.

Vulnerability Score:

As discussed in Section 4.5.7 (C)(2) above, the Vulnerability Scores for the Commercial Aircraft scenario were much lower than the Vulnerability Scores for the small aircraft attack. The preferred mitigation measures for aircraft are to prevent the use of the aircraft by terrorists. TSA performs and oversees airport security for commercial air traffic developing a program that involves 20 layers of defense. [60] These measures are directed at passengers, employees, and suppliers. Measures begin with intelligence collection, screening passengers, inspecting luggage, placing security personnel on the aircraft, hardening the doors to the airplane cabins, and monitoring/tracking the flight paths. Flight Plan management at local airports is recommended as a mitigation measure although its impact on the Vulnerability Score is small compared to the TSA prevention methods.

Consequence Score:

In order to reduce the unmitigated Consequence Score for the inbound transit through the busiest fishing seasons (approximately June – Sept) policy or guidance should be established mandating night transits (beginning late afternoon or early evening) for all loaded LNG vessels during this time. *(Recommendation 7.3.2 (B)(8))*. The boating population is drastically reduced during the evening hours reducing the population density on this track leg from a "medium" to a "low" and would reduce the Consequence Score from "3" to a "1". This policy should be enforced every year for the

[60] www.TSA.gov/what_we_do/layers/index

Buoy “10“ season and should be evaluated each year for the other two major fishing seasons - Sport Sturgeon and Spring Chinook/Steelhead.

5.4.2.7 Mines

As discussed in Section 4.5.7 (D), mines are indiscriminate weapons designed to deny the use of a port or waterway rather than to target specific vessels. Vulnerability to mines during the offshore transit was considered very low due to the wide area involved. However, the ability for a small vessel to cross ahead of an inbound LNG ship at close range to quickly deploy a mine was deemed feasible during the entire river transit.

There were two track legs with unmitigated Risk Scores in the “Mitigate” or “Consider” category:

- Seasonal along track legs 3, 4, 5 & 6 during the heaviest fishing seasons (June – Sept) (Mitigate), and

- Seasonal along track Leg 6 between Hammond Marina and Tansy Points (June – September) (Consider).

The Vulnerability Score given to this threat was a Medium “3” throughout the river transit. Consideration was given to have a lesser vulnerability in the mouth of the river where the channel was wider and the currents more variable, but without a means to keep the attacking vessel further from the ships, the vulnerability was kept constant, knowing that the consequence difference would provide some differentiation in Risk Scores. A lower Vulnerability Score of “2” was assigned while the vessel was transiting track legs 7 & 8 because of the proximity of 3 or more tugs maneuvering the vessel.

With the Vulnerability Score relatively constant throughout the transit up the river, the different Risk Scores calculated in Appendix F are based on the varying Consequence Scores of a successful mining attack along the different track legs.

Vulnerability Score:

Halcrow recommends the establishment and enforcement of security zones as described in the small boat attack and projectile attack from a boat scenario. The security zones effectively reduce the Vulnerability Scores by providing a means to keep small craft seeking to lay the mines away from an inbound LNG vessel. The escort vessels would also serve as a means to visually sight a mine ahead of the ship so that evasive action can be taken. At higher MARSEC's the helicopter surveillance/escort provides a better means of observing the track line and vessels along it.

The routine operations to maintain MDA also contribute to the overall mitigation effort for this threat as well as others that involve threats delivered using boats.

Consequence Score:

Implementing mitigation measures to reduce the Vulnerability Scores alone does not reduce the unmitigated Risk Score along track legs 3, 4, 5 & 6 during the busiest fishing seasons to the "Document" category. The Consequence Score of "3" must also be reduced. The most effective means of reducing the Consequence Score is to mandate night time transits (beginning late afternoon or early evening) for all loaded LNG vessels during the three busiest fishing seasons. The night time transit policy should be enforced every year for the busiest portions of the Buoy "10" Season and should be evaluated each year for the other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead to determine whether or not enforcement of the night time transit is required. This changes the scenario from a Zone 1 overlapping a medium density population area, "3" to a Zone 1 overlapping a low population density, "1". We recognize that it will be much more difficult to spot a floating mine in the dark; however, as discussed above, the key is keeping small craft away from an inbound LNG vessel.

Summary of Proposed Risk Mitigation Measures for the "Mining" Scenario:

Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Mining" scenario:

a. Recommend establishment of a moving security zone around inbound LNG ships from the CR Buoy to the dock as follows:

- MARSEC 1 – 500 yards with provision for vessels traveling at speed reduced to bare steerageway or stopped/anchored to enter the zone to within 100 yards of ship.

- MARSEC 2 – 500 yards without exception.

- MARSEC 3 – 1000 yards ahead of ship and 500yards on the sides and astern. *(Recommendation 7.3.2(B)(9))*

b. Recommend enforcement of the established zones around inbound ships with the following:

- MARSEC 1 – Minimum of two (2) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug.

- MARSEC 2 – Minimum of three (3) armed boats beginning between Buoy 6 and Buoy 14 where the ship slows to tether tug. The boats shall be armed with crew served weapons (machine guns).

- MARSEC 3 – Minimum of four (4) armed boats beginning between Buoy 6 and Buoy 14 armed with crew served weapons (machine guns) and armed helicopter escort. POSCON Team embarked on inbound ship with portable crew served weapons for defense. POSCON Team to remain on board until vessel completes unloading of cargo. *(Recommendation 7.3.2(B)(10))*

c. To establish a consistency in practice/expectations between all of the various agencies and organizations that may be involved in providing security, security zone enforcement should normally begin somewhere between Buoys 8 & 10 when the LNG vessel will slow down to tether with one of the escort tugs. The exact start location may vary somewhat based on where the escort tugs are able

to meet the LNG vessel and commence their escort. *(Recommendation 7.3.2 (B)(11))*

d. Policy or guidance should be developed mandating night transits (beginning in the late afternoon or early evening) for all loaded LNG vessels during the three busiest fishing seasons (approximately June – Sept). The busiest portions of the Buoy "10" salmon season in August early September is large enough to require enforcement of the night time transit requirement each year. The other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead should be evaluated each year to determine whether or not enforcement of the night time transit requirement is required. *(Recommendation 7.3.2 (B)(8))*

e. Recommend that at MARSEC Level 3 the small boat vessel escort should be supported with an air escort. *(Recommendation 7.3.2 (B) 12))*

f. At MARSEC Level 3 the marinas down river of the Astoria-Megler Bridge should be closed to outgoing small boat traffic one hour prior to an LNG vessel arriving at the Bar. *(Recommendation 7.3.2 (B) 17))*

5.4.2.8 Diver Attack

The threat of an underwater diver attack was not considered credible while the ship is underway so we only addressed the scenario with the LNG vessel moored at the dock. The unmitigated Risk Score for the diver attack scenario with the vessel moored at the dock was a "3" (document). The Risk Score was driven by the Vulnerability Score of "3".

Vulnerability Score:

The most effective means of reducing the Vulnerability Score is by denying divers easy access to the moored LNG vessel. This is best accomplished by establishing and enforcing a fixed security zone around the vessel.

a. Recommend establishment of a fixed security zone around moored LNG ships as follows:

- MARSEC 1 – 200 yards fixed security zone around terminal dock.
- MARSEC 2 – Increase the fixed security zone to 500 yards.
- MARSEC 3 – Increase the fixed security zone to 1000 yards. *(Recommendation 7.3.2 (C)(6))*

b. Recommend enforcement of the established security zones around moored LNG ships with the following:

- MARSEC 1 – Minimum of one (2) armed boats.
- MARSEC 2 – Minimum of two (2) armed boats or one (1) armed boat and installation of a boat barrier.
- MARSEC 3 – Minimum of three (3) armed boats capable of response (portable crew served weapons for defense) or two (2) armed boats capable of response and installation of a boat barrier. *(Recommendation 7.3.2 (C)(6))*

c. Recommend additional security measures to include 24 hour video surveillance coverage of the LNG dock area, routine security rounds by facility personnel and develop local sensitivity to unauthorized diving in the area of the terminal. *(Recommendation 7.3.2 (C)(7))*

d. Recommend that underwater pier inspections be conducted as follows:

- At MARSEC Level 2 the underwater portion of the pier should be inspected within seven (7) days of an LNG vessel arrival.
- At MARSEC Level 3 the underwater portion of the pier should be inspected prior to the arrival of each LNG vessel. *(Recommendation 7.3.2 (C)(17))*

5.4.2.9 Sabotage

The Risk Scores indicate that mitigation is needed:

- In the Buoy 10 area during the busiest fishing seasons (Mitigate), and

- Along track leg 6 from Hammond Marina past Tansy Point (Consider).

The Vulnerability Score was a "3" throughout the river transit. With the Vulnerability Score constant, the different Risk Scores calculated in Appendix F are based on the varying Consequence Scores of a successful sabotage attack along the different track legs.

Sabotage involves an internal threat that is best mitigated with personnel aboard the vessel. The International Ship and Port Facility Security (ISPS) Code requires most large commercial vessels, including LNG ships, on international voyages, to have a security plan that is designed to reduce the vessel's vulnerability to an internal threat. It provides for screening of materials brought aboard ship, access controls for spaces aboard ship, and conducting security rounds by trusted personnel of the ship's crew to prevent sabotage. In accordance with the requirements of the International Ship and Port Facility Security (ISPS) Code, a ship security plan should call for additional security measures to be conducted by the crew as the security level increases.

In addition to the efforts of the crew and company to provide for their own security, the addition of POSCON Teams provides an external means to ensure the implementation of the security plans. The POSCON team provides an armed guard force placed in vital spaces aboard the ship to monitor and ensure the safe operation of the ship.

As discussed in Section 4.5.7(E)(2) the Intentional Release of Cargo scenario was not considered credible.

Vulnerability Score:

The Vulnerability Score for MARSEC 1 was a "3" throughout the river transit. The Vulnerability Score can be reduced by:

- Ensuring that the Ship Security Officer on the inbound LNG vessel is properly implementing the vessel's security plan, and

- Conducting POSCON boardings to ensure that the Master maintains control of the vessel throughout its transit up the River.

Halcrow recommends that offshore security boardings be conducted on inbound LNG ships to verify the information submitted in the ANOA and to ensure that the Ship Security Plan is being properly implemented. The frequency of boardings should be performed in accordance with Table 5-3.

Halcrow recommends that "Positive Control" (POSCON) boardings be performed in accordance with Table 5-3. The suggested levels of boardings in Table 5-3 are in percentages of total LNG inbound ships over a monthly period: 25% at MARSEC 1, or approximately 1-2 per month if the Q-Max ships are employed, or 2-3 per month if smaller ships are used; 50% at MARSEC 2, which equates to approximately 4 per month if the larger ships are employed or approximately 6 per month for smaller ships, and; 100% of the ships if permitted entry at MARSEC 3. MARSEC 3 has never been set in the United States and if it is set it is expected to be short in duration. It should be noted that these are suggestions recognizing that there is other classified Coast Guard guidance that may require other frequency levels. This report is not intended to supersede Coast Guard policy, simply suggest a level that is deemed appropriate to both maintain proficiency of POSCON boarding team members and to provide adequate deterrence level at MARSEC 1 and 2. At MARSEC 3, it is presumed that all practical security measures will be implemented to support any LNG ship permitted to enter port in a high threat environment.

Consequence Score:

Implementing mitigation measures to reduce the Vulnerability Scores alone does not reduce the unmitigated Risk Score along track legs 3, 4, 5 & 6 during the busiest fishing seasons to the "Document" category. The Consequence Score of "3" must also be reduced. The most effective means of reducing the Consequence Score is to mandate night time transits. This changes the scenario from a Zone 1 overlapping a medium density population area, "3", to a Zone 1 overlapping a low population density, "1".

Halcrow recommends that policy or guidance be developed mandating night transits (beginning late afternoon or early evening) for all loaded LNG vessels during the three busiest fishing seasons (approximately June – Sept). The busiest portions of the Buoy "10" salmon season in August early September is large enough to require enforcement of the night time transit requirement each year. The other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead should be evaluated each year to determine whether or not enforcement of the night time transit requirement is required.

Summary of Proposed Risk Mitigation Measures for the "Sabotage" Scenario:

Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Sabotage" scenario:

a. Recommend that offshore security boardings be conducted on inbound LNG ships to verify the information submitted in the ANOA and to ensure the ship's security plan is being fully implemented. The percentage of offshore security boardings should be in accordance with the recommendations of Table 5-3. At MARSEC 3, security boarding should be conducted on all inbound LNG vessels. *(Recommendation 7.3.2 (A)(4))*

b. Recommend that POSCON boardings be conducted on arriving LNG vessels. The percentage of POSCON boarding conducted should increase as the MARSEC Level increases in accordance with Table 5-3. At MARSEC 3, all inbound LNG vessels should have a POSCON team onboard. *(Recommendation 7.3.2 (A)(7))*

c. Recommend that policy or guidance be developed mandating night transits (beginning late afternoon or early evening) for all loaded LNG vessels during the three busiest fishing seasons (approximately June – Sept). The busiest portion of the Buoy "10" salmon season in August early September is large enough to require enforcement of the night time transit requirement each year. The other two major fishing seasons – Sport Sturgeon and Spring Chinook/Steelhead

should be evaluated each year to determine whether or not enforcement of the night time transit requirement is required. *(Recommendation 7.3.2 (B)(8))*

5.4.2.10 Hijacking

There are three (3) Hijacking scenarios with Risk Scores in the "Mitigate" or "Consider" ranges:

1. "High speed collision into an underway Cruise Ship" ("6" – Consider),
2. "Ram cruise ship at Astoria dock" ("9" - Mitigate), and
3. "Target Astoria-Megler Bridge" ("9" - Mitigate).

These three hijacking scenarios required mitigation based on the access/proximity to critical infrastructure, key assets, and the highest population center in the lower Columbia River, Astoria. Considering the investment of time, funding, people and training to complete a successful hijacking scenario, it was not deemed credible to target anything less than the highest value targets in the area.

Underway cruise ships provide the only maritime related "key asset" that are in port on a reliable basis. It has already been recognized in this report the difficulty of trying to plan on two ship meeting in the channel considering the unknowns of scheduling. Cruise ships probably have the most rigorous adherence to schedules of any ships in the river. Even so, trying to plan a meeting situation of an inbound LNG ship and a cruise ship leaves too much to chance to credibly plan an attack. The consequence involved if an attack did occur on a cruise ship by a hijacked LNG ship was high enough to warrant a "consider" based on Risk Score. This scenario is effectively mitigated by implementing the one-way traffic management plan for ships.

More likely, a hijacking scenario would involve fixed, rather than underway, targets. Targets available on the Astoria waterfront could be a moored cruise ship or the Astoria-Megler Bridge. These scenarios received "mitigate" Risk Scores.

Vulnerability Score:

The Vulnerability Score for using the LNG ship to ram an underway cruise ship was only a "2" recognizing the difficulty in timing/coordinating the attack. The other two

scenarios received Vulnerability Scores of "3" as the proposed targets were fixed and thus more vulnerable. The recommended vulnerability mitigation measures are the same for all three scenarios. Each of the vulnerability mitigation measures discussed below is intended to either make it more difficult for a terrorist to take control of an LNG vessels or to warn the Coast Guar if such a hijacking takes place.

The first mitigation measure is for the Coast Guard to conduct security boardings prior to an LNG vessel entering the Columbia River. The intent of these boardings is to determine whether or not the vessel has implemented proper security measures to maintain control of the vessel and would be an opportunity for the Master or other member of the crew to inform the Coast Guard if there was a problem on the vessel.

The second mitigation measure is periodic positive control (POSCON) boardings of LNG vessels. The POSCON team should board the vessel before it enters the River and ride the vessel to the dock. The POSCON team would serve to ensure that the master and crew maintained control of the inbound LNG vessel. The POSCON team would serve as the enforcement arm, similar to the vessel escorts enforcing security zones. The frequency of these POSCON boardings should be significantly increased at the higher MARSEC levels.

The third vulnerability mitigation measure is the two tugs that will escort incoming LNG vessels and the other two tugs which will be standing by in the vicinity of the dock. Once alerted to a problem these tugs would be able to deflect an LNG from striking a moored LNG vessel or the Astoria-Megler Bridge. As a minimum the tugs could push the hijacked vessel aground along the channel's edge.

Finally, it is recommended that a pilot duress code be established with the Coast Guard.

Consequence Score:

One mitigation measure which would reduce the Consequence Score for the "High speed collision into an underway Cruise Ship" scenario would be for the Captain of the Port to establish a vessel management policy to prevent meeting/passing situations between cruise ships and inbound LNG ships.

No mitigation measures were identified for reducing the Consequence Scores for the last two scenarios "Ram cruise ship at Astoria dock" and "Target Astoria-Megler Bridge". As a result, the Consequence Scores for these two scenarios remained high – "3".

Summary of Proposed Risk Mitigation Measures for the "Hijacking" Scenario:

Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Sabotage" scenario:

a. Recommend that offshore security boardings be conducted on inbound LNG ships to verify the information submitted in the ANOA and to ensure the ship's security plan is being fully implemented. The percentage of offshore security boardings should increase as the MARSEC Level increases. At MARSEC 3, security boarding should be conducted on all inbound LNG vessels. *(Recommendation 7.3.2 (A)(4))*

b. Recommend that POSCON boardings be conducted on arriving LNG vessels. The percentage of POSCON boarding conducted should increase as the MARSEC Level increases. At MARSEC 3, all inbound LNG vessels should have a POSCON team onboard. *(Recommendation 7.3.2 (A)(7))*

c. Policy or guidance should be developed requiring two commercial tugs to meet inbound LNG ships to provide assistance if needed to respond to an accidental or intentional scenario. A third and possibly fourth tug if the pilots feel the LNG ship is large enough should meet the arriving LNG vessel between Buoys 25 & 27, and also be available to assist. *(Recommendations 7.3.2 (B)(6&7))*

d. The COTP should establish duress codes with the Bar Pilots who will be piloting the inbound LNG vessels. *(Recommendation 7.3.2 (B) (21))*

e. Policy or guidance should be developed establishing mandatory one-way Commercial ship traffic on the Desdemona Shoal Channel from Buoy 8 to the proposed Oregon LNG Terminal whenever a loaded LNG ship is inbound. This

policy would prohibit all meeting/passing situations between LNG and other large commercial vessels including cruise ships. *(Recommendation 7.3.2 (B)(5))*

5.4.3 Enclosure (3) to NVIC 05-05

Table 5-3 was developed as a check to ensure all of the mitigation strategies identified in Enclosure (3) to NVIC 05-05 are addressed in this WSA.

Table 5-3
Risk Management Strategies & Risk Mitigation Measures for LNG Ship Underway

Mitigation Strategy	Location	Reference Tool		Proposed Mitigation Measure	Recommendations by MARSEC Level *		
		Summer	Winter		1	2	3
1. Pre-Arrival Security Boarding	Pilot/USCG Boarding Area west of CR Buoy	O	O	Yes	Periodic (25%)	Periodic (50%)	All (100%)
2. Pre- Arrival Safety Inspection	Pilot/USCG Boarding Area west of CR Buoy	O	O	Yes	Periodic	Periodic	Periodic
3. Safety/ Security Zone or RNA	Track legs 1 & 2 to Buoy 4	N/R	N/R	Yes (from CR Buoy – track leg 2)	100% 500yds w/100yds entry authorized if vessels moving slow or anchored	100% 500 yd	100% 1000 yd fore/aft – 500yds on sides
	Track legs 2-5 from Buoy 4	#	N/R	Yes	100% 500yds w/100yds entry auth if vessels moving slow or anchored	100% 500 yd	100% 1000 yd fore/aft – 500yds on sides
	Track leg 3-5 during Buoy 10 Season	R	N/A	Yes	100% 500yds w/100yds entry auth if vessels moving slow or anchored	100% 500 yd	100% 1000 yd fore/aft – 500yds on sides

Mitigation Strategy	Location	Reference Tool		Proposed Mitigation Measure	Recommendations by MARSEC Level *		
		Summer	Winter		1	2	3
3. (Con't) Safety/ Security Zone or RNA	Track leg 6 through midway on 7	R	N/R	Yes	100% 500yds w/100yds entry auth if vessels moving slow or anchored	100% 500 yd	100% 1000 yd fore/aft – 500yds on sides
	Track leg 7 (from midpoint) through 8	#	#	Yes	100% 500yds w/100yds entry auth if vessels moving slow or anchored	100% 500 yd	100% 1000 yd fore/aft – 500yds on sides
4. Vessel Escort for Safety/ Security Zones	Track legs 1 & 2 to Buoy 4	N/R	N/R	No	N/A	N/A	N/A
	Track legs 2-5 from Buoy 4	O	N/R	Yes (Year round - Start vic Buoy 8 wx depending)	Escort with minimum of 2 armed boats for deterrence***	Escort with minimum of 3 armed boats with one capable of response***	Escort with min of 4 boats with all capable of response***
	Track leg 3-5 during Buoy 10 Season	R	N/A	Yes (Year round)	Escort with minimum of 2 armed boats for deterrence***	Escort with minimum of 3 armed boats with one capable of response***	Escort with min of 4 boats with all capable of response***
	Track leg 6 through midway on 7	R	N/R	Yes (Year round)	Escort with minimum of 2 armed boats for deterrence***	Escort with minimum of 3 armed boats with one capable of response***	Escort with min of 4 boats with all capable of response***
	Track leg 7 (from midpoint) through 8	O	O	Yes (Year round)	Escort with minimum of 2 armed boats for deterrence***	Escort with minimum of 3 armed boats with one capable of response***	Escort with min of 4 boats with all capable of response***

Mitigation Strategy	Location	Reference Tool		Proposed Mitigation Measure	Recommendations by MARSEC Level *		
		Summer	Winter		1	2	3
5. Positive Control Measures	Embark west of CR buoy/ride to Dock	O	#	Yes	25%	50%	100%
6. Commercial Tug Escort	Track legs 1 & 2 to Buoy 4	N/R	N/R	No	N/A	N/A	N/A
	Track legs 2-5 from Buoy 4	#	N/R*	Yes (2 tugs meet ship @ Buoy 6)	100% (One tug tethered)	100% (One tug tethered)	100% (One tug tethered)
	Track leg 3-5 during Buoy 10 Season	R	N/A	Yes	100% (One tug tethered)	100% (One tug tethered)	100% (One tug tethered)
	Track leg 6 through midway on 7	O	N/R	Yes (1-2 more tugs meet ship betw Buoys 25 & 27)	100%	100%	100%
	Track leg 7 (from midpoint) through 8	#	#	Yes	100%	100%	100%
7. Day (Night) Transit	Entire Route	O	#	Yes	N/R	100%	100%
8. Electronic Surveillance	Track legs 1 & 2 to Buoy 4	N/R	N/R	No	N/A	N/A	N/A
	Track legs 2-5 from Buoy 4	#	N/R	Yes	Camera system installed/available for use when needed	Camera system actively monitored	Camera system actively monitored
	Track leg 3-5 during Buoy 10 Season	#	N/A	Yes	Camera system installed/available for use when needed	Camera system actively monitored by USCG	Camera system actively monitored by USCG
	Track leg 6 through midway on 7	O	N/R	Yes	Camera system installed/available for use when needed	Camera system actively monitored by USCG	Camera system actively monitored by USCG

Mitigation Strategy	Location	Reference Tool		Proposed Mitigation Measure	Recommendations by MARSEC Level *		
		Summer	Winter		1	2	3
8. (Con't) Electronic Surveillance	Track legs 7 (from midpoint) through 8	#	#	Yes	Facility waterfront camera system installed/ monitored	Facility waterfront camera system installed/ monitored	Facility waterfront camera system installed/ monitored
9. Restrictions on commercial/ public activity	Track legs 1 & 2 to Buoy 4	N/R	N/R	No	N/A	N/A	N/A
	Track legs 2-5 from Buoy 4	#*	N/R*	Yes (One-way ship traffic from Buoy 8 / no passing / tug escorts)	100%	100%	100%
	Track leg 3-5 during Buoy 10 Season	#*	N/A	Yes (Night transit only for LNG)	100%	100%	100%
	Track leg 6 through midway on 7	O	N/R	Yes (One-way ship traffic from Buoy 8 / no passing / tug escorts)	100%	100%	100%
	Track leg 7 (from midpoint) through 8	R**	#*	Yes (One-way ship traffic from Buoy 8 / no passing / tug escorts)	100%	100%	100%
10. Police Presence on piers/ structures along waterway	Track leg 6 through midway on 7 (Tansy Pt & Hammond marina)	O	N/R	Yes	100% Police Sweep Hammond marina area & Tansy Pt in advance of ship.	100% Police presence Hammond & Tansy Pt as ship passes	100% Police presence Hammond & Tansy Pt as ship passes

Mitigation Strategy	Location	Reference Tool		Proposed Mitigation Measure	Recommendations by MARSEC Level *		
		Summer	Winter		1	2	3
11. Presence by Air	Track legs 1 & 2 to Buoy 4	N/R	N/R	Yes	Periodic General area surveillance	Flight over area in advance of inbound transit	Flight over area in advance of inbound transit
	Track legs 2-5 from Buoy 4	#*	N/R*	Yes	Periodic harpats	Flight over area in advance of inbound transit	Dedicated air escort of ship working with surface escort
	Track leg 3-5 during Buoy 10 Season	#*	N/A	Yes	Periodic harpats	Flight over area in advance of inbound transit	Dedicated air escort of ship working with surface escort
	Track leg 6 through midway on 7	O	N/R*	Yes	Periodic harpats	Flight over area in advance of inbound transit	Dedicated air escort of ship working with surface escort
	Track leg 7 (from midpoint) through 8	#	#	Yes	Periodic harpats	Flight over area in advance of inbound transit	Dedicated air escort of ship working with surface escort
12. Warning signals for community	Track leg 6 through midway on 7	O	#	Yes	Install for use as needed	Install for use as needed	Install for use as needed
13. Area of Refuge for community	Track legs 2-5 from Buoy 4	O	N/R	No	N/A	N/A	N/A
	Track leg 3-5 during Buoy 10 Season	#	N/A	No	N/A	N/A	N/A
	Track leg 6 through midway on 7	R	N/R				
	Track leg 7 (from midpoint) through 8	O	O	No	N/A	N/A	N/A

Mitigation Strategy	Location	Reference Tool		Proposed Mitigation Measure	Recommendations by MARSEC Level *		
		Summer	Winter		1	2	3
14. Educational Programs for Community	Track legs 2-5 from Buoy 4	O	N/R	Yes	Periodic		
	Track leg 3-5 during Buoy 10 Season	#	N/A	No	Not necessary		
	Track leg 6 through midway on 7	R	N/R	Yes	Periodic		
	Track leg 7 (from midpoint) through 8	O	O	Yes	Periodic		

- Not likely to have an impact N/R – Not Required N/A – Not Applicable
* Percentages indicated do not reflect any existing USCG guidance. Only suggested levels of activity, primarily intended to reflect a trend of increasing levels at various MARSEC or constant
** Used category for heavy marine traffic since that is used in the moored table for consistency
*** Deterrence capability means at least small arms – Response means mounted crew served weapon.

5.4.4 Intentional/Security Scenarios (Moored)

A review of the dockside scenarios on the worksheets in Appendices E and F and on the summary sheets, reveals that there are no scenarios, either accidental or intentional at MARSEC 1, that have Risk Scores above the "Document" level. Essentially no mitigation measures were warranted. That is because of the relatively isolated location of the pier extending off the tip of the Skipanon Peninsula and the system of scoring that is primarily focused on impact on populations. The land that is overlapped by Zones 1 and 2 from a moored LNG ship is considered low population density. Zone 2 extends south from where the ship would be located to about midway through the Weyerhaeuser plant property. It does not encompass any of the condominiums, house or marinas in the harbor area of the Skipanon Waterway. Therefore, at a low threat level, little mitigation is necessary. The same findings are generally found when comparing recommendations of the risk management reference tool if the risk factors of related to population were used.

Upon review of the fishing boat numbers provided in the Oregon Department of Fish and Wildlife table which was included in Governor Kulongoski's letter to the Federal Energy Regulatory Commission (FERC) dated December 13, 2007, it was

determined to consider the months of June through September as the potentially "heavy marine traffic" months. These months incorporate the Columbia River sport sturgeon fishing, sport salmon, most of sport crabbing, ocean sport salmon, commercial gillnetting, and a majority of the ocean commercial fishing with perhaps the exception of ocean crabbing.

Table 5-4 provides a side by side comparison of the dockside mitigation measures recommended in the Reference Tool using the "Heavy Marine Traffic" risk factor and the mitigation measures recommended in Enclosures G, H, I & J. It indicates that a safety/security zone around the facility is recommended in the months, June - September, but not likely to have much of an impact in the winter months when the boating density is low. It also suggests that a boat barrier is optional, as are physical barriers and diver sweeps.

To compliment these findings, a review of the risk assessment worksheet for dockside scenarios was done at the various threat levels to derive a comprehensive mitigation strategy.

5.4.4.1 Small Boat Attack (USS Cole type and Projectile Launched from Boat)

While at MARSEC 1 the Risk Scores for both the USS Cole type Small Boat Attack and the Projectile Launched from Boat scenarios were both scored as "document". The Vulnerability Scores were high. "4"; however, the Consequence Scores were low, "1". Nonetheless, a security zone mitigation measure with two enforcement boats was applied at MARSEC Level 1 because the Reference Tool recommended it and because it would be required at MARSEC 2. The security zone at MARSEC Level 1 was set at 200 yards to minimize the impact on other traffic in the area. This 200 yard security zone aligns with the security zone required in the Waterway Suitability Report (WSR) for the Bradwood facility. At MARSEC Level 2 the Risk Score rises to a "6" even with the security zones already in place. Therefore it is recommended that the size of the security zone be increased from 200 yards to 500 yards for MARSEC Level 2. Increasing the security zone size to 500 yards sufficiently mitigates the risk at the higher threat level, but also impacts the waterway by overlapping the Skipanon Waterway. Boats may still come and go, transiting through

the security zone, but they would need clearance and observation by the security boats. If LNG ships are permitted entry at MARSEC 3, it is envisioned that the security zone would be enforced by a minimum of 3 boats. The boats at all MARSECs should be armed and the crews must have recognized law enforcement authority to enforce federal security zones. As with the underway escort boats, the dockside patrol boats should, at MARSEC level 2 & 3, be equipped with crew-served weapons capable of responding to an incoming small boat threat. *(Recommendation 7.3.2 (C)(6))*

Electronic surveillance (closed circuit TV) cameras should be installed on the facility waterfront with the capability of seeing in low light/low visibility and with enough magnification to monitor the waters off Tansy Point to Astoria. They are intended to be used to observe activity on the dock during loading and observe the water to support enforcement of the security zone. *(Recommendation 7.3.2(C)(7))*

An electronic loudspeaker/hailing system such as the Long Range Acoustic Device (LRAD) should be installed for facility security personnel or the boat crews to warn off small boats encroaching on the security zone. These systems are "point" acoustic warning systems such that warnings can be made to specific small boats in the area. Any small boats ignoring warnings from the LRAD should be considered high risk vessels and intercepted by the facility's security boats. *(Recommendation 7.3.2(C)(16))*

5.4.4.2 Ship Ramming

As discussed in the underway section, this scenario involves the hijacking of another large ship (over 50,000 GT) with the intent of ramming the hijacked vessel into a moored LNG vessel.

While at MARSEC 1 the Risk Score for this scenario was "document". However, at MARSEC 2 & 3 the unmitigated Risk Score would be an "8" & "12" respectively if no mitigation measures were put in place. The driver at each MARSEC Level was the Vulnerability Score. The Consequences Scores remained low, "1", at all MARSEC Levels.

Vulnerability Score:

The threat of a large commercial vessel ramming a moored LNG vessel is addressed in both the accidental scenarios and in the intentional scenarios. The consensus of the Risk Assessment Work Shop participants was that the most effective mitigation measure would be the LNG terminal tugs physically stopping or deflecting an approaching LNG vessel. The Work Group agreed that at MARSEC Level 1, the standby tugs should be underway between the ship's berth and the ship channel whenever a ship of over 50,000 GT passed the terminal. At MARSEC Level 2 the consensus was that the facility tug should actively escort ships of over 50,000 GT past the terminal to ensure a safe/uneventful transit. At MARSEC Level 3 the escort tug should be tethered to any passing vessel.

The Simulator Study, completed shortly after the Work Shop, strongly supported the idea of requiring the LNG terminal tugs to actively escort all passing traffic of over 50,000 GT. "To minimize the risk of a transiting vessel with a casualty colliding with an LNG ship docked at the terminal, one tug should escort the transiting vessel between Buoy 27 and 31 and a second tug should be on instant standby in the terminal basin. Under most circumstances the tugs will not be required to make up to the vessel, but in the case of a vessel that is proving difficult to handle, the pilot may require the tug to make up to the vessel."[61] If the Pilots determined through the simulator that it is possible for a large commercial vessel to accidentally allide with a moored LNG vessel, it is certainly possible that a large commercial vessel could be intentionally steered into a moored LNG vessel. Using the mooring tugs as escort tugs for all large commercial vessels transiting past a moored LNG vessel is the most effective defense against both the accidental and intentional scenarios. The escort tug may not be able to completely control the hijacked vessel and the hijacked vessel may be able to allide with a moored LNG vessel but the escort tug could ensure that the allision occurs at a lesser angle than 90 degrees.

[61] "Oregon LNG Simulation Report" Dated 01/03/08. Page 7.

Finally, the use of POSCON boarding teams on a periodic and random basis is considered useful as a deterrent to someone that might be considering such a plan. At MARSEC 3, there should be POSCON teams aboard all large ships transiting past the terminal when an LNG ship is present and offloading

Summary of Proposed Risk Mitigation Measures for the "Ship Ramming" Scenario:

Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Sabotage" scenario:

a. Policy or guidance should be developed requiring that At MARSEC Level 1, at least one of the Oregon LNG Terminal tugs to escort all up bound and down bound ships of over 50,000 GT between Buoys 27 and 31. A second tug shall be in immediate standby in the terminal basin. *(Recommendation 7.3.2 (C)(10))*

b. Policy or guidance should be developed requiring that at MARSEC 2 & 3, two tugs should escort ships of greater than 50,000 GT transiting past the facility. At MARSEC 3 one of the tugs should be tethered to the stern of the passing ship. *(Recommendation 7.3.2 (C)(11))*

c. Policy or guidance should be developed requiring that Periodic "Positive Control" (POSCON) boardings of all inbound and outbound vessels should be conducted on commercial vessels of greater than 50,0000 GT. To protect against the intentional ramming scenario. The frequency of these POSCON boardings should be significantly increased at the higher MARSEC Levels. POSCON teams should be embarked on all vessels transiting past a moored LNG vessel. *(Recommendation 7.3.2 (B)(13))*

5.4.4.3 Air Threat (Small Aircraft and Commercial)

In the small aircraft attack scenario, the small aircraft was not deemed likely to be able to penetrate the double hull of these tankers as mentioned in the underway section. That is not definitive and they most likely could penetrate the upper tanks. At MARSEC 1, there were only minimal mitigation measures recommended based on the

threat level and resulting Risk Score. At MARSEC 2 the Risk Score is a "16" (Mitigate) and at MARSEC 3 the Risk Score is an "18" (Mitigate).

Vulnerability Score:

As mentioned previously, there are few effective mitigation measures to prevent a small aircraft from crashing onto a moored LNG vessel. Two mitigation measures which would help reduce the Vulnerability Score are dockside security boats armed to shoot down an attacking small aircraft and the standby tugs. The need for dockside security boats was already addressed in the Small Boat Attack scenario. As discussed in the underway threat section above, we believe that at MARSEC Level 1 the crew of the dockside security boat would hesitate to shoot down an approaching aircraft fearing that it was a simple mistake. However, at higher MARSEC Levels we believe the crew would be much more likely to shoot. Therefore as in the underway scenarios, the dockside security boats should be armed with crew served weapons (machine guns) at MARSEC Levels 2 & 3. Strict rules of engagement would be necessary, but at the higher threat levels and an aircraft making an unmistakable hostile approach may warrant such action.

A second mitigation method would be to moor the standby tugs outboard of the LNG vessel. As discussed in the Small Boat Attack scenario the moored tug boats would serve as a physical deterrent. The attacking aircraft would have to try to hit the LNG vessel between the moored tug boats or strike the LNG vessel above the moored tug boats. If a boat barrier is installed, that is viewed as an obstacle to complicate an attempt to dive in low. Even with these additional measures we did not reduce the Vulnerability Score at MARSEC 2.

At MARSEC 3, the same mitigation measures would apply with the additional action of placing Coast Guard or other Law Enforcement personnel on the LNG ship with crew served weapons and a ready helicopter prepared to launch to investigate suspicious small aircraft reports. Coordination with the Astoria Regional Airport can be done to restrict air traffic flying from runway 13/31. The combination of all of these mitigation measures resulted in the reduction of the Vulnerability Score form a "4" to a "3". Halcrow and the participants of the Work Shop felt confident that at MARSEC

Level 3 the crews of the security boats and the armed teams on the LNG vessel would be alert enough and willing to fire at an approaching small aircraft.

No additional action is required for commercial air due to security measures applied by TSA.

Summary of Proposed Risk Mitigation Measures for the "Small Aircraft and Commercial Aircraft Attack" Scenarios:

Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Small Aircraft Attack" scenario (No mitigation measures are required to defend against the Commercial Aircraft Attack scenario):

a. A fixed security zone should be established around the LNG facility and any vessel moored to it. Two security boats should remain underway to enforce the security zone any time an LNG vessel is moored to the facility. At MARSEC 2 & 3 the security boats should be armed with crew served weapons (machine guns). At MARSEC 3 the number of security boats should be increased to 3. *(Recommendation 7.3.2(C)(6))*

b. Policy or guidance should be developed requiring that at MARSEC 2 & 3 the standby tugs should moor on the outboard side of the moored ship to provide a physical barrier on the outboard side of the vessel and require an attacking aircraft to either try to fly between the moored vessels or to strike the LNG ship above the tugs, well above the waterline of the LNG vessel. *(Recommendation 7.3.2 (C)(12))*

c. At MARSEC 3 a POSCON Team with a portable crew served weapon (machine gun) should be deployed on a moored LNG vessel to provide point defense against light aircraft (and small boats). *(Recommendation 7.3.2 (C)(13)*

5.4.4.4 Diver Threat

The Risk Score at MARSEC 1 is a "3" (Document) based on a Vulnerability Score of "3". Even though an underwater attack would be very difficult due to the strong currents, low visibility and cold water a conservative Vulnerability Score of "3" was

assigned. At MARSEC 2 the unmitigated Risk Score would be a “6” and at MARSEC Level 3 the unmitigated Risk Score would be a “9”.

Vulnerability Score:

A 50 yard security zone should be established around the LNG terminal pier whenever an LNG vessel is not moored to the pier. The intent is to keep innocent vessels away from the pier and highlight suspicious vessels. The 50 yard security zone does not require a security boat on scene actively patrolling the security zone. However, the facility should have a security boat on immediate standby to respond if there is someone violating the zone and not cooperating with the facility personnel.

At MARSEC Level 1, a 200 yard security zone should be established around all moored LNG vessels. The security zone should be actively patrolled by two security boats.

At MARSEC Level 2, it is recommended that the fixed security zone around the moored vessels should be increased from 200 yards to 500 yards. This would greatly complicate a diver’s approach to the vessel and increase the response time of the boats patrolling the security zone. The security zone should be actively patrolled by two security boats.

At MARSEC Level 3, the fixed security zone should be increased to 1,000 yards and the number of security boats increased from 2 to 3. Again the intent is to make approaching the pier from under water as difficult as possible and to ensure that there are sufficient security boats to monitor the larger security zone.

Underwater pier inspections are also recommended at increasing MARSEC Levels. At MARSEC Level 2 an underwater inspection of the facility pier should be conducted within seven (7) days of an LNG vessel arrival. At MARSEC 3 an underwater inspection of the pier should be conducted immediately prior to the arrival of each LNG vessel.

Summary of Proposed Risk Mitigation Measures for the "Diver" Scenarios:

Halcrow recommends implementation of the following mitigation measures to reduce the risk of the "Diver" scenario:

a. A fixed 50 yard security zone should be established around the LNG facility pier for all MARSEC Levels. This security zone shall be in effect any time there is not an LNG vessel moored to the pier. *(Recommendation 7.3.2(C)(6))*

b. A fixed security zone should be established around all LNG vessels moored to the pier which:

   (i) At MARSEC Level 1 would extend 200 yards around an LNG vessel moored to the terminal pier. The 200 yard security zone should be patrolled by 2 armed security boats.

   (ii) At MARSEC Level 2 the security zone should be extended to 500 yards around a moored LNG vessel. The 500 yard security zone should be patrolled by 2 armed security boats or one security boat and a floating security barrier.

   (iii) At MARSEC Level 3 the security zone should be extended to 1,000 yards around a moored LNG vessel. The 1,000 yard security zone should be patrolled by 3 armed security boats or 2 armed patrol boats and a floating security boom. *(Recommendation 7.3.2(C)(6))*

c. Oregon LNG shall conduct underwater pier inspections searching for potential explosive devices as follows:

   (i) At MARSEC Level 2 the underwater portion of the pier shall be inspected within seven (7) days of an LNG vessel arrival.

   (ii) At MARSEC Level 3 the underwater portion of the pier shall be conducted prior to the arrival of each LNG vessel. *(Recommendation 7.3.2(C)(17))*

5.4.4.5 Sabotage

This scenario is generally expected to be addressed by the ship's company and crew. One of the key mitigation measures is the crew's implementation of the ship's security plan as required by the International Ship and Port Facility Security (ISPS) Code. There are a number of other personnel in the area that contribute to presence and therefore reduce the vulnerability to sabotage.

Vulnerability Score:

The Vulnerability Score for this scenario was primarily mitigated by the LNG vessel's crew implementing the vessel's approved security plan. The mitigation measures provided in the security plan increase with increasing security levels thus the vulnerability decreases with increasing security levels.

Additional mitigation measures that should be implemented are:

a. Offshore security boardings should be conducted on a periodic basis with the periodicity increasing as the MARSEC Level increases. At MARSEC Level 3, all inbound LNG vessels should be boarded. The goal of these offshore security boardings is, in part, to ensure that the master and crew are in control of the vessel and that the crew has properly implemented the ship security plan. *(Recommendation 7.3.2 (A)(4))*

b. At MARSEC Level 3, the POSCON teams should remain aboard the vessel until the cargo offload is complete. *(Recommendation 7.3.2(A)(7))*

5.4.4.7 Anti-boat Barrier

A floating security boom/anti-boat barrier was addressed as a mitigation measure in three scenarios; "Small Boat Attack", "Stand –Off Weapon Launched from a Boat", and the "Small Aircraft Attack".

The floating barrier would be most effective in mitigating the "Small Boat Attack" scenario by physically blocking an attacking small boat from reaching the moored LNG vessel. In this scenario, the security boom was teamed with one dockside security boat.

The floating barrier would replace one of the 2 required dockside security boats. There are strengths and weakness to this approach. A properly designed floating security boom would serve as an excellent barrier to an attacking small boat. The boom would never "sleep" nor would it hesitate or become "confused" in stopping an attacking small boat. The floating security boom would be most effective at MARSEC 1 where the dockside security boats are most lightly armed and the crews the least alert. However, potential attackers could offset the security boom by attacking with two small boats. The first attacking boat could blow its way though the security barrier while the second boat would pass through the damaged barrier and attack the LNG vessel. The two dockside security boat approach allows the security boats to support each other. The two dockside security boat approach would be the most effective at heightened security levels when the boats are the most heavily armed and the crews are the most alert.

The anti-boat barrier was also proposed as a mitigation measure to defend against the "Stand–Off Weapon Launched from a Boat" and "Small Aircraft" attack scenarios. In both scenarios the presence of a floating security boom, which stands 8 – 10 feet above the water, would cause the attacker to "shoot high" to avoid the barrier netting and thus strike the LNG vessel well above the waterline. The Sandia Report consequences (Zones of Concern) are based on the assumption that the vessel is holed at the waterline and that all the cargo above the hole(s) empties out of the damaged tanks. If the hole(s) are above the waterline then less cargo will be released and the consequences as Zones of Concern will be smaller.

The feasibility of a small boat security boom (anti-boat barrier) will be investigated by Oregon LNG. It first must be determined if a boom would work in this open area with heavy currents. There are questions about how it would be installed and anchored in the open area surrounding the pier able to withstand the currents and without impeding the ship handling evolutions needed to moor the ship and delays in getting the ship underway in an emergency.

Table 5-4
Risk Management Strategies & Risk Mitigation Measures for LNG Ship Moored

Mitigation Strategy	Reference Tool*		Proposed Mitigation Measure	Recommendations by MARSEC Level **		
	Summer	Winter		1	2	3
1. Pre-Arrival Security Boarding	O	O	Y	Periodic (25%)	Periodic (50%)	Periodic (100%)
2. Pre-Arrival Safety Inspection	O	O	Y	Periodic	Periodic	Periodic
3. Safety/Security Zone/RNA	R	#	Y	Establish year round – 200yds	Increase range to 500yds	Increase range to 500yds
4. Vessel Escort/Patrol for Safety/Sec Zones	O	O	Y	Enforce zone year round – 2 boats capable of response	Enforce zone year round – 2 boats capable of response	Enforce zone year round – 3 boats capable of response
5. Electronic Surveillance	#	#	Y***	Low light/low vis CCTV	Low light/low vis CCTV	Low light/low vis CCTV
6. Restrictions on commercial/public activity	#	#	Y	Speed limit & tug escorts for passing ships	Speed limit & tethered tug escorts for passing ships	Speed limit & tethered tug escorts for passing ships
7. Police presence on piers/structures along waterway	#	#	N	N/A	N/A	N/A
8. Presence by Air	#	#	N	Periodic Harbor patrols	Daily Harbor patrols	Twice daily while ship inport
9. Warning Signals for Community	#	#	Y	Signal installed for underway ship available	Signal installed for underway ship available	Signal installed for underway ship available
10. Areas of Refuge	O	O	N	Not necessary – numerous buildings in area	Not necessary – numerous buildings in area	Not necessary – numerous buildings in area

Mitigation Strategy	Reference Tool*		Proposed Mitigation Measure	Recommendations by MARSEC Level **		
	Summer	Winter		1	2	3
11. Education Program for Community	O	O	Y	Upon Request		
12. Diver Sweep of Pier **	O	O	Y	As necessary to respond to suspicious sighting	Upon setting MARSEC 2 and then in response to suspicious sightings	Prior to Arrival of each ship
13. Anti-boat barriers	O	O	****	Enforce security zone with 1 boat if boom installed		
14. Physical barrier around moored vessel	O	O	Y*****	Install barriers on edges and along pier so small boats not able to approach ship on the shore side		
15. Cargo Transfer Monitoring	#	#	Y	Periodic	Periodic	100%

- Not likely to have an impact Y – Yes N – No N/A – Not applicable
* Considered the area within 1800m of terminal dock to have heavy marine traffic during summer months (May –October) considering Skipanon Waterway, Youngs Bay, and Columbia River ship channel
**Percentages recommended and do not supersede existing CG policy Reflects increased frequency of mitigaton based on increased MARSEC.
***IAW MTSA requirements.
**** Anti-boat barrier being investigated by company to see if it can be feasibly installed in this location.
***** Investigating means to block off access to side of moored ship on pier side..

6. RESOURCE REQUIREMENTS FOR THE PROPOSED RISK MITIGATION MEASURES

6.1 RESOURCE REQUIREMENTS

Table 6.1 below provides a:

- List of the required resources for the proposed mitigation activities,
- Potential sources of those resources, and
- The gaps in the resources required and those available from the different sources.

The table identifies resources available from the major agencies in the area. We have not confirmed whether or not the included agencies are willing to support the resource requirements and if so if these resources would in fact be made available or if the Agency would expect to be provided with additional resources. The table does not develop response resource needs as those will be addressed in the Emergency Response Plan.

NOTE* - In establishing many of the “Required Resources” we have provided performances percentages. These percentages are Halcrow estimates and are not intended to supersede any internal Coast Guard performance standards.

Table 6-1
Resource Requirements for the Proposed Risk Mitigation Measures

#	Activity	Required Resources	Potential Sources	Gap
1.	Pre-Arrival Security Boardings	**MARSEC 1** – Small boat to transport 4 to 6 person security boarding team on periodic basis (25%). With 2 -3 LNG vessel arrivals per week this would total approximately: 5 persons x 2.5 vessels per week x 4 hours per boarding x 25% = 13 person hours/week	Sector Portland Oregon, Oregon State Police, Washington State Department of Fish and Wildlife, Clatsop County Sheriff	**MARSEC 1** Approximately 2.5 small boat hours/week & 13 Boarding Team Member hours/week.
		MARSEC 2 – Small boat to transport 4 to 6 person security boarding team. – Suggested raising frequency to 50% of arriving ships. With 2 – 3 LNG arrivals per week this would total approximately: 5 persons x 2.5 vessels per week x 4 hours per boarding x 50% = 25 person hours/week		**MARSEC 2** Approximately 5 small boat hours/week & 25 Boarding Team Member hours/week.
		MARSEC 3 - Small boat and 4 to 6 person boarding team – Suggested raising frequency to 100% of arriving ships. 5 persons x 2.5 vessels per week x 4 hours per boarding x 100% = 50 person hours/week		**MARSEC 3** Approximately 10 small boat hours/week & 50 Boarding Team Member hours/ week.
2.	Pre-Arrival Safety Inspections	Safety boarding team of 3 people.	Sector Portland Oregon.	None – Combine safety inspections with security inspections discussed above.

#	Activity	Required Resources	Potential Sources	Gap
3.	Establish Safety/Security Zones	Regulations must be drafted to establish a moving safety/security zone around loaded LNG vessels and a fixed security zone around the terminal pier. The resources required are 1 person to draft the Safety/ Security Zone regulations. 1 person 1 week to draft.	Sector Portland Oregon to draft the proposed Regulations or Oregon LNG to draft and Sector Portland to review the proposed Regulations.	Sector Portland requires 1 person 1 week (5 person days) to draft regulation or 1 person 2 days (2 person days) to review regulations drafted by Oregon LNG.
4.	Underway Security Zone Enforcement	**MARSEC 1** - Two small boats to enforce the security zone. 3 person crew x 2.5 escorts/week x 4 hours/escort x 2 boats = 60 person hours/week.	Sector Portland Oregon, Oregon State Police, Washington State Department of Fish and Wildlife, Clatsop County Sheriff.	**MARSEC 1** Approximately 20 boat hours/ week & 60 Boat Crew hours/week.
		MARSEC 2 - Three small boats to enforce the security zone. 3 person crew x 2.5 escorts/week x 4 hours/escort x 3 boats = 90 person hours/week.		**MARSEC 2** Approximately 30 boat hours/week & 90 Boat Crew hours/week.
		MARSEC 3 - Four small boats to enforce the security zone. 3 person crew x 2.5 escorts/week x 4 hours/escort x 4 boats = 120 person hours/week		**MARSEC 3** Approximately 40 boat hours/week & 120 Boat Crew hours/week.

#	Activity	Required Resources	Potential Sources	Gap
5.	Fixed Security Zone Enforcement	**MARSEC 1 & 2** - Two small boats to enforce the security zone. Boat Crew Hours 3 person crew x 2.5 vessels/week x 18 hours/port visit x 2 boats = 270 person hours/week. Boat Hours 2.5 vessels/week x 18 hours/port visit x 2 boats = 90		**MARSEC 1 & 2** Approximately 90 boats hours/week & 270 Boat Crew hours/week
		MARSEC 3 - Three small boats to enforce the security zone. Boat Crew Hours 3 person crew x 2.5 vessels/week x 18 hours/port visit x 3 boats = 360 person hours/week. Boat Hours 2.5 vessels/week x 18 hours/port visit x 3 boats = 135		**MARSEC 3** Approximately 135 security boats hours/week & 405 Boat Crew hours/week
6.	Positive Control Measures (POSCON) LNG Vessels	**MARSEC 1**: 4 to 6 person boarding team and small boat to transport Conduct on periodic basis – just enough to maintain qualifications & proficiency suggest 1/month.	Sector Portland Oregon, Oregon State Police, Washington State Department of Fish and Wildlife, Clatsop County Sheriff	Minimal. POSCON Team provided by having Security Boarding Team remain on board vessel for transit to pier. Security Boardings increase at same percentage rate as the POSCON percentages.
		MARSEC 2: 4 to 6 person brdg team and small boat to transport team. Conduct on more frequent basis – suggest 50% of LNG ships.		
		MARSEC 3: 4 to 6 person boarding team and small boat to transport team. Conduct on more frequent basis – suggest 100% of LNG ships.		

#	Activity	Required Resources	Potential Sources	Gap
6 a.	Positive Control Measures (POSCON) Non-LNG Vessels	**MARSEC 1 -** 4 to 6 person boarding team and small boat to transport Conduct on periodic basis – just enough to maintain qualifications & proficiency suggest 1/month.	Sector Portland Oregon, Oregon State Police, Washington State Department of Fish and Wildlife, Clatsop County Sheriff, City of Warrenton Police Department	**MARSEC 1** Minimal. POSCON Team can maintain proficiency by riding LNG vessels as discussed above. on board vessel for transit to pier.
		MARSEC 2: 4 to 6 person brdg team and small boat to transport team. Conduct on more frequent basis – suggest 50% of LNG ships. Approximately 10 vessels cross the Bar each day (Section 2.4) 10 vessels x 4 – 6 person Team per vessel x 3 hours x 50% = 75 POSCON Team Hours/day		**MARSEC 2** Approximately 24 boat hours & 75 POSCON Team Member hours/day
		MARSEC 3: 4 to 6 person boarding team and small boat to transport team. Conduct on more frequent basis – suggest 100% of LNG ships. 10 vessels x 4 – 6 person Team per vessel x 3 hours x 100% = 150 POSCON Team Hours/day		**MARSEC 3** Approximately 24 boat hours & 150 POSCON Team Member hours/day

#	Activity	Required Resources	Potential Sources	Gap
7.	Commercial Tug Escort	Minimum of two tugs meet arriving LNG vessels after Buoy #6. Third and, if required for that size LNG vessel, a fourth tug required to meet arriving vessel by Tansy Point. Three of the tugs will remain on immediate standby while an LNG vessel is unloading. At MARSEC 1 at least one of the tugs should escort all upbound and downbound vessels of over 50,000 GT between Buoys 27 & 31. At MARSEC 2 & 3 two tugs should be used for the escort. Three of the tugs must be rated 75 metric tons static bollard pull/push or greater and equipped with Class 1 Fire Fighting capability	Oregon LNG and contracted tug company to provide 3 75 Bollard metric ton tractor tugs with class 1 fire fighting capability. A fourth tug should also be contracted to handle the largest LNG vessels	Three (3) tugs of 75 metric ton bollard pull plus a fourth support tug. Oregon LNG to purchase or contract required tug services.
8.	Day Transit/Night Transit Only	No resources needed – requires policy only and monitoring through Bar Pilots.	N/A	None
9.	Electronic Surveillance of Waterway	CCTV system capable of monitoring the Columbia River transit from the mouth of the River to the proposed terminal site. Coast Guard currently operates a CCTV system monitoring portions of the River entrance. Additional cameras will be required to monitor those areas of the river not currently covered by the Coast Guard's existing CCTV system.	Oregon LNG Note: CCTV system for monitoring waters around proposed LNG Facility will be addressed in Facility Security Plan.	CCTV cameras to monitor areas of the River not currently covered

#	Activity	Required Resources	Potential Sources	Gap
9.	Electronic Surveillance of Waterway	Watch standers required for monitoring the CCTV systems. The system must be available at all security levels. The system should be actively monitored during MARSEC Levels 2 & 3.	Coast Guard or Oregon LNG Security personnel	Watch standers to monitor CCTV at MARSEC Levels 2 & 3.
10.	Restrictions on Commercial and Public Activities	Policy or guidance should be developed mandating night transits for all loaded LNG vessels during the three busiest fishing seasons. Policy or guidance should be developed requiring that, at MARSEC 3, marinas down river of the Astoria-Megler Bridge will be closed to outgoing small boat traffic one hour prior to an LNG vessel's arrival at the Bar. Policy or guidance should be developed restricting large vessels (over 50,000 GT) from transiting past the Oregon LNG terminal at over 10 knots whenever an LNG vessel is moored at the terminal should be evaluated. Policy or guidance should be developed establishing mandatory one-way commercial ship traffic on the Desdemona Channel from Buoy 8 to the proposed Oregon LNG Terminal when a loaded LNG ship is inbound. Other down bound traffic to be held back from transiting past the Astoria-Megler Bridge.	Columbia River Bar Pilots currently control shipping traffic crossing the Bar and transiting the Desdemona Channel to minimize meetings. Bar pilots will enforce.	Minimal – Policies should be developed and promulgated as part of the Vessel Transit Management Plan discussed below.

#	Activity	Required Resources	Potential Sources	Gap
11.	"Police Presence" on Piers along Waterway	Law enforcement personnel should patrol/monitor shore side areas during inbound LNG vessel transits. 1 police car with 1 – 2 police officers for approximately 2 hours per inbound transit. 1.5 police officers x 2.5 transits/week x 2 hours = 7.5 police hours per week 2.5 transits/week x 2 hours = 5 police vehicle hours/week	Warrenton City Police	Approximately 7.5 police hours per week & 5 police vehicle hours per week.
12.	"Presence by Air"	Periodic air surveillance is currently done in area to observe boating activity and provide visible LE presence as a deterrence measure regardless of LNG. Other critical infrastructure (Astoria-Megler Bridge) in area. No need to increase frequency under MARSEC 1, but may coordinate timing of flights to cover area ahead of transiting LNG ship.		
		MARSEC 1: Periodic air surveillance of the area. We do not consider it necessary to provide air support to escorts unless specific intelligence received. No additional air patrols/resources recommended.		**MARSEC 1** None. Routine overflights are adequate

#	Activity	Required Resources	Potential Sources	Gap
12.	"Presence by Air"	**MARSEC 2**: Increased aircraft patrols of area. Recommend air patrols for 50% of arriving LNG vessels. 2 to 3 vessel arrivals per week x 2 hours/patrol x 50% = 2.5 aircraft hours/week at MARSEC Level 2	USCG Air Station Astoria	**MARSEC 2** 2.5 aircraft hours and crew/week
		MARSEC 3: 100% coverage. 2 to 3 vessel arrivals per week x 2 hours/patrol x 100% = 5 aircraft hours/week at MARSEC Level 3	USCG Air Station Astoria	**MARSEC 3** 5 aircraft hours and crew/week
13.	Warning Signals for Community	Warning System for the Cape Disappointment State Park breakwater/beach area.	Oregon LNG to take lead in developing the Emergency Response Plan and funding the notification program.	There is currently no warning system in the Cape Disappointment State Park.
14.	Educational Programs for Community	On going public education campaigns to provide information about LNG and safety precautions using web based means, video, or personal talks to organizations or schools. Education programs must be tailored to meet the various needs of all the river users, including commercial and recreational boaters, local businesses, local residents and tourists. Not associated with higher threat conditions.	Oregon LNG to take lead in developing the Emergency Response Plan and funding the education programs. Coast Guard and State and local agencies to review/approve.	There are no LNG educational programs.

#	Activity	Required Resources	Potential Sources	Gap
15.	Cargo Transfer Monitoring	On site inspection of training records and observation of cargo transfer activity by USCG personnel. 2 person team required to monitor cargo transfer operation or parts of it. 2 persons x 2 -3 vessels per week x 3 hours hook up/disconnect = 15 person hours week	Coast Guard Sector Portland or Oregon LNG to conduct transfer monitors.	None if Oregon LNG can conduct the monitors. If Oregon LNG does not have legal authority to conduct monitors then gap would be approximately 15 person hours/week.
16.	Diver Sweeps	**MARSEC 1** – Commercial divers to sweep piers if something suspicious observed.	Oregon LNG to contract diver service as needed.	None – Oregon LNG to provide/contract for diver services
		MARSEC 2 – Conduct diver sweep of pier upon declaration of rise in security condition and then again every week for duration of enhanced security condition.	Oregon LNG to contract diver service as needed.	
		MARSEC 3 – Conduct diver sweep of pier upon declaration of rise in security condition and then before each ship arrival.	Oregon LNG to contract diver service as needed.	
17.	Anti-boat barrier	Anti-boat barrier (boom) around moored LNG vessels. Boat barrier may be used to replace one of the dockside security boats.	Oregon LNG to investigate feasibility.	None. Oregon LNG to provide security boats or combination of boat boom and a boat.
18.	Dynamic Under Keel Clearance System	Immersion study of deep draft LNG vessels transiting the Bar during summer and winter conditions	Oregon LNG supported by Sector Portland and Bar Pilots	None. Oregon LNG to conduct study and provide needed equipment.
19.	LNG Vessel Inspection	LNG Vessels are subject to (at a minimum) annual Coast Guard safety and security inspections. Assume safety and security inspections conducted concurrently. 2 persons x 2 days = 4 person days	Oregon LNG may be able to contract this (i.e. ABS) or Coast Guard	4 person days of contractor or Coast Guard Vessel Inspector

#	Activity	Required Resources	Potential Sources	Gap
20.	Facility Inspections	LNG facilities are subject to (at a minimum) annual Coast Guard safety and security inspections. Assume safety and security inspections are conducted concurrently. 2 persons x 2 days = 4 person days	Oregon LNG may be able to contract this (i.e. ABS) or Coast Guard.	4 person days of contractor or Coast Guard Facility Inspector
21.	LNG Vessel familiarization training	Columbia River Bar pilots to complete LNG vessel familiarization training prior to first LNG vessel arriving at the facility.	Oregon LNG to work with the Pacific Maritime Institute or some other training institute to provide the required training.	Training must be provided to all appropriate Pilots.
22.	Develop a Vessel Transit Management Plan	The Transit Management Plan should be developed in coordination with the Bar Pilots, Escort Tug Operators, Security Assets and the Coast Guard prior to the first transit. 2 persons 2 months	Coast Guard led or Oregon LNG led with Coast Guard support	If Coast Guard leads, the gap is 2 persons 2 months = 4 person months If Oregon LNG leads Sector Portland gap is ¼ person 2 months = ½ person months
23.	Navigational Aids	A method other than buoys should be employed to indicate the extent of the dredged basin. Buoys were not recommended in the Oregon LNG Simulation Report because they are prone to damage by passing ships.	Coast Guard to provide aids if federal aids to navigation Oregon LNG to provide if they are to be private aids	Coast Guard authorization/funding to install ATON if federal aid required.
24.	Gas Detection Capability	Emergency Response Plan to address First Responder (Police and Fire) need to be equipped and trained to use and maintain gas detection equipment to respond to LNG releases along the river transit or at the Oregon LNG Terminal.	Oregon LNG to develop Emergency response Plan and coordinate and fund purchase of appropriate gas detectors for First Responders	With the exception of the HAZMAT team in Astoria, gas detection capability is not resident to First Responders along the transit route and at the facility.

#	Activity	Required Resources	Potential Sources	Gap
25.	Facility Security Measures	LNG facilities must meet the security requirements outlined in 33 CFR Part 105. A Facility Security Plan must be developed and implemented. The Facility Security Plan must be reviewed and approved. Review and approval requires approximately 5 person days	Oregon LNG to develop and implement the Facility Security Plan. Coast Guiard to review and approve Plan.	Coast Guard resources needed to review and approve the Facility Security Plan – approximately 5 person days.
26.	Oregon LNG is seeking approval to receive LNG Vessels of up to 265,000 cubic meters.	Oregon LNG requests approval to handle LNG vessels of up to 266,000 cubic meters. The Sandia Report is based on consequences of LNG breaches, spills and hazards associated with LNG vessels having a cargo capacity of no more than 148,000 cubic meters and spill volumes of 12,500 cubic meters. There remains some question as to the size of hazard zones for accidental and intentional discharges and the potential increased risk to public safety from LNG spills on water from larger vessels. No additional resources required by Sector Portland.	Based on discussions with Mr. Mike Hightower it was determined that the Zones of Concern which will be recommended by Sandia in the new LNG Study are less than 10% larger than the Zones of Concern in the current Sandia Report. In completing this WSA, Oregon LNG used Zones of Concern which are 12% larger than the Zones of Concern defined in the current Sandia Report, thereby exceeding the less than 10% increase predicted by Mr. Hightower.	If the new Sandia Report recommends Zones of Concern greater than 12% larger than the existing Zones or if the Coast Guard adopts Zones of Concern greater than 12% larger than the existing Zones, Oregon LNG will have to complete a revised WSA for the larger vessels or limit arrivals to vessels of no more than 148,000 cubic meters.

6.2 MARITIME LAW ENFORCEMENT ASSETS CURRENTLY OPERATING IN THE LOWER COLUMBIA RIVER AREA

6.2.1 US Coast Guard Group/Air Station Astoria

6.2.1.1 Station Cape Disappointment

(i) 1 - 52 ft Motor Life Boats (MLB)

(ii) 2 - 47 ft MLBs

(iii) 2 – 22 ft Response Boat Small (RBS)

6.2.1.2 Air Station Astoria

(i) 3 – HH60 Helicopters

6.2.2 Oregon State Police

(i) 1 – 24 ft Rigid Hull Inflatable Boat (RHIB)

(ii) 1 – 23 ft North River (flat bottom boat for river work)

6.2.3 Washington State Department of Fish and Wildlife

(i) 1 – 27 ft RHIB (kept at the CG Station)

(ii) 1 - 22 ft RHIB

(iii) 1 - 56 ft Westport (primarily for offshore fisheries)

6.2.4 Clatsop County Sheriff

(i) 1 – 28 ft RHIB

(ii) 1 – 21 ft Safeboat

(iii) 1 – 23 ft North River

(iv) 1 – Dive Team

7. CONCLUSIONS AND RECOMMENDATIONS

The results of this WSA found that the Lower Columbia River is suitable for the transportation of LNG from the mouth of the River up to the proposed Oregon LNG Terminal in Warrenton, OR. With the implementation of the risk management strategies recommended in this WSA, it is believed that the risk can be mitigated to an acceptable level. The measures recommended take into consideration the need for security while minimizing the impact on the waterway users. The measures are also scalable so that if the security level (MARSEC) rises, so will the mitigation measures. As discussed in Section 4.4.3, “Assumptions for Safety Scenarios”, and Section 4.5., “General Security Assumptions”, the mitigation measures only apply to loaded (inbound) LNG vessels.

7.1 NAVIGATION

The waterway is suitable for Q-MAX size LNG tankers to navigate safely from the Columbia River Entrance to the Terminal Site. The waterway is currently used by ships of comparable size in terms of gross tonnage and the increased level of vessel traffic caused by the addition of these LNG vessels has been handled by the waterway in the past. (Section 4.3.1)

The dredging of the turning basin was evaluated and modified by members of the Columbia River Bar Pilot’s Association while completing the Simulation Study completed in November 2007. Assuming the turning basin and dock area are dredged as planned, the LNG ships will be able to maneuver safely and moor as proposed.

7.2 PUBLIC SAFETY

Transporting LNG is not without risk. It is a flammable product and everyone involved with the transport thereof must constantly be aware of that fact and vigilantly adhere to the prescribed safety and security measures. However, the danger should be kept in perspective. The LNG industry has an exemplary safety record over its 40 plus years of operations. The Columbia River Bar Pilots, who would be piloting the ships up the Columbia River to the proposed LNG Terminal in Warrenton, also have an excellent safety record throughout the planned route.

The studies conducted by Sandia and other research institutions have been extensive. Modeling done by Sandia established "Zones of Concern" for a major LNG release over water that reflect levels of impact on public safety due to the radiant heat of the fire, and the potential for a vapor cloud to form without igniting.

The Zones of Concern were established based on extremely conservative modeling. They represent what could happen under a number of accidental and intentional attack scenarios, assuming the worst case scenarios to establish the outer ranges. Intentional acts were found to create the largest holes/spills, which, in turn, drove the limits of the three Zones of Concern. Accidental scenarios resulted in much less damage to the ship, which in turn created smaller spills and smaller Zones of Concern.

The Zones of Concern defined in the Sandia Report were based on LNG vessels of up to approximately 148,000 cubic meters, the largest size vessels at the time. The LNG shipping is growing and the LNG ships have grown considerable in size. The newest vessels are called Q-Max vessels and have a capacity of approximately 266,000 cubic meters. As with most of the other planned LNG terminals, Oregon LNG is seeking approval to receive these larger LNG vessels. As discussed in Section 3.5.2 we addressed the larger size LNG vessel by using "Expanded" Zones of Concern. These larger Zones of Concern were used in calculating the Consequence Scores in Section 4 of this report.

The intended track line was examined for its proximity to critical infrastructure, key assets, and population centers to determine potential impacts based on the (Expanded) Zones of Concern. The only critical infrastructure that falls within a Zone of Concern (Zone 3) along the intended ship track line would be the Astoria-Megler Bridge. Key assets that may come in proximity of LNG tankers in the Columbia River are cruise ships visiting Astoria. Much of the city of Warrenton, which according to the 2000 U.S. census is a low population density area (less than 1,000 persons per square mile), was treated as a medium density population density area because of the large influx of tourists that visit the area each summer.

7.3 RISK MITIGATION MEASURES

The following section outlines specific Risk Mitigation Measures that are recommended for inbound (loaded) LNG vessels. Note many of the recommendations propose development of specific operational guidelines. Halcrow strongly recommends that these recommendation/guidelines be vetted/further developed through the Area Maritime Security Committee (AMSC) and published in some form of Waterways Management Plan. The "Chesapeake Bay Liquefied Natural Gas (LNG) Operations Management Plan" developed by Sector Baltimore and Sector Hampton Roads serves as an excellent model.

(A) OFFSHORE RISK MITIGATIONS

(1) Arriving LNG vessels are required to submit an Advanced Notice of Arrival (ANOA) for the Coast Guard to screen crew and ship condition/state of security plan. (Section 3.3.5) (33 CFR Part 160)

(2) The Ship's Master of arriving LNG vessels are required to test the vessel's main engines and steering and document the successful tests in the ship's log prior to entry. (Section 3.3.5) (33 CFR Part 164)

(3) Intentionally left blank.

(4) Offshore Security Boardings should be conducted on a periodic basis with the periodicity increasing as the MARSEC Level increases. Recommend boarding all inbound LNG vessels at MARSEC Level 3. Offshore Safety Inspections should be conducted based on the currency of the vessel's COC and some level of random periodicity. (Section 3.3.5(c)), (Section 5.4.2.9), (Section 5.4.2.10) (Section 5.4.4.5)

(5) Intentionally left blank.

(6) Compulsory pilotage ensures safe navigation and control of ship by known individual that can communicate problems aboard as necessary to shore. Columbia River Bar Pilots shall ensure sufficient tide conditions and weather to permit safe entry.

(7) Periodic positive control (POSCON) boardings should be conducted on inbound loaded LNG vessels. The frequency of the POSCON boardings should increase as the MARSEC Level increases. Recommend that POSCON teams be embarked on all LNG vessels permitted entry at MARSEC 3 and that the POSCON Team remain onboard until cargo operations are completed. (Section 5.4.2.9) (Section 5.4.2.10) (Section 5.4.4.5) (Section 5.4.4.6)

(B) CROSSING THE BAR AND TRANSITING THE RIVER MITIGATIONS

(1) All Bar Pilots who will pilot the larger LNG vessels should be required to complete ship handling training for the new class of vessel. (Section 4.3.2.4) (Section 5.4.1.1(3))

(2) Policy or guidance should be developed outlining acceptable weather parameters for loaded LNG vessels seeking to enter the Columbia River and transit up to the Oregon LNG Terminal. The CH2M Hill/Oregon LNG Simulation Report dated 01/03/2008 (Appendix T) conducted at the Pacific Maritime Institute by the Columbia River Pilots, recommends limits of:

(i) Sixteen foot waves and twenty five knots of wind for inbound Bar crossings, and

(ii) Twenty five knot winds for River transits. (Section 4.3.2(a), (Section 5.4.1.1) (Section 5.4.1.2)

(3) A dynamic under keel clearance system should be installed to provide real time information of vessel immersion and the resulting clearance under the keel. (Section 4.3.2.3)

(4) Policy or guidance should be developed establishing a maximum speed for loaded and unloaded LNG vessels transiting the Columbia River. The Oregon LNG Simulation Report states that the Pilots were able to control the ship model after a simulated “hard over” when the vessel’s speed was less than 8 knots and the vessel had a tethered escort tug through the center lead aft and a second tug assisting. It is recommended that a maximum speed of 8 knots be adopted until actual experience can be used to select a more suitable speed. (Section 4.3.2 (g))

(5) Policy or guidance should be developed establishing mandatory one-way commercial ship traffic on the Desdemona Channel from Buoy 8 to the proposed Oregon LNG Terminal whenever there is an inbound LNG vessel. At MARSEC 1, all outbound traffic should be held upriver of the Astoria-Megler Bridge. At MARSEC 2 & 3, all outbound vessels should be held north of Rice Island. Inbound commercial vessels should not be allowed to overtake transiting LNG vessels. The ship characteristics in the simulator showed a great deal of crabbing if there was any significant wind. Therefore, until the Bar Pilots have more experience with the new vessels, the one-way traffic requirement should also remain in place for outbound LNG vessels. (Section 4.3.2(j)) (Section 5.4.2.2) (Section 5.4.2.10) (Section 5.4.1.2)

(6) Policy or guidance should be developed requiring two commercial tugs to meet inbound LNG ships to provide assistance if needed to prevent an incident or respond immediately to remove the ship from danger or stabilize the situation. The commercial tugs should meet inbound LNG vessels in the vicinity of Buoy 6 weather permitting to escort the vessel to the dock. One tug should tether to the stern of the ship through the centerline chock, as soon as conditions permit, after Buoy 6 or after crossing the Bar in rough conditions (provided slowing down for the tug does not jeopardize the execution of a safe turn around Buoy 10 and Buoy 14). The second tug should be standing by to escort the vessel, as soon as conditions permit, after crossing the Bar. (Section 4.3.2) (Section 4.3.3) (Section 5.4.1.1) (Section 5.4.1.2) (Section 5.4.2.9) (Section 5.4.2.10)

(7) The third, and possibly fourth tug should meet the arriving LNG vessel between Buoys 25 and 27, before reaching the Tansy Point turn. It is envisioned that the tethered tug will stay astern and a tug will tie off to each side of the bow of the ship to be prepared to maneuver the ship to mooring. (Section 5.4.2.9) (Section 5.4.2.10)

(8) Policy or guidance should be developed mandating night transits (beginning late afternoon or early evening) for all loaded LNG vessels during the three busiest fishing seasons (approximately June – Sept). The busiest portions of the Buoy "10" salmon season in August early September is probably large enough to require enforcement of the night time transit requirement each year. However, the night transit policy should be evaluated each year for the other two major fishing seasons – Sport

Sturgeon and Spring Chinook/Steelhead to determine whether or not enforcement of the night time transit requirement is required. (Section 5.4.1.1) (Section 5.4.1.2) (Section 5.4.2.1) (Section 5.4.2.2) (Section 5.4.2.3) (Section 5.4.2.5) (Section 5.4.2.6) (Section 5.4.2.7) (Section 5.4.4.9)

(9) Policy or guidance should be developed establishing a moving security zone around all inbound LNG vessels beginning as the ship passes the CR Buoy and continuing to the dock. At MARSEC 1, the zone is recommended to be 500 yards with a provision for vessels to be able to come within 100 yards provided they are moving as slowly as possible while maintaining steerageway. At MARSEC 2, the zone is recommended to be 500 yards with no exceptions. At MARSEC 3, the security zone recommended is 1000 yards fore and aft of the ship and 500 yards on the sides. (Section 5.4.2.1) (Section 5.4.2.3) (Section 5.4.2.4) (Section 5.4.2.5) (Section 5.4.2.7)

(10) The security zones should be enforced for all inbound transits. Two security escort boats are needed at MARSEC 1. A minimum of three boats are required to adequately enforce the zone at MARSEC 2 and a minimum of four at MARSEC 3. At MARSEC 1, the boat should be armed for deterrence. At MARSEC 2 and 3, the boat should be armed for response with crew-served weapons. (Section 5.4.2.1) (Section 5.4.2.3) (Section 5.4.2.4) (Section 5.4.2.5) (Section 5.4.2.7)

(11) To establish a consistency in practices/expectations between all of the various agencies and organizations that may be involved in providing security, security zone enforcement should normally begin somewhere between Buoys 8 and 10 when the LNG vessels will slow down to tether with one of the escort tugs. The exact start location may vary somewhat based on where the escort tugs are able to meet the LNG vessels and commence their escort. (Section 5.4.2.1) (Section 5.4.2.3) (Section 5.4.2.4) (Section 5.4.2.7)

(12) At MARSEC 3 an armed helicopter is also recommended to participate in conducting the ship escort along with the surface boats. If the small boats are unable to commence the escort until the ship is well into or past the Bar, the helicopter can provide an air escort and conduct surveillance of the area earlier. (Section 5.4.2.1) (Section 5.4.2.3) (Section 5.4.2.4) (Section 5.4.2.7)

(13) Periodic "Positive Control" (POSCON) boardings of inbound and outbound commercial vessels of over 50,000 GT should be implemented to protect against the two intentional ramming scenarios, LNG vessels transiting inbound and LNG vessels moored. The scenario of an outbound commercial vessel of over 50,000 GT colliding with an inbound LNG vessel only requires that outbound commercial vessels carry POSCON teams. However, the scenario where a large commercial vessel allides with an LNG moored to the terminal requires that both inbound and outbound commercial vessels of over 50,000 GT should have POSCON teams onboard. The frequency of these POSCON boardings should be significantly increased at the higher MARSEC levels. At MARSEC 3, all vessels of over 50,000 GT transiting past a moored LNG vessel should have a POSCON team on board. (Section 5.4.2.2) (Section 5.4.4.2)

(14) At MARSEC 3 the POSCON Team should be armed with one or more machine guns to provide "point source protection" capability. If an unknown/suspicious small boat or aircraft is clearly directed at the ship, machine gun fire directed from the ship would provide the final layer of active defense. (Section 5.4.2.1) (Section 5.4.2.5)

(15) If ship entry is approved at MARSEC 3, communications should be established between USCG and air traffic control of transit area (ATC Seattle) prior to ship entering the Columbia River and throughout the vessel's transit to ensure that no unusual aircraft activity is occurring at the time. (Section 5.4.2.5)

(16) Intentionally left blank.

(17) At MARSEC 3 it is recommended that the marinas down stream of the Astoria-Megler Bridge should be closed to outgoing small boat traffic one (1) hour prior to an LNG ship's arrival at the Bar. (Section 5.4.2.1) (Section 5.4.2.3) (Section 5.4.2.4) (Section 5.4.2.7)

(18) One of the most effective mitigation measures to reduce an LNG vessel's vulnerability to a stand-off weapon attack from shore is to provide police presence along the shore to detect and deter attempts to launch weapons at a passing LNG vessel. It is recommended that the Warrenton City Police should be contracted to sweep the Warrenton waterfront area prior to the ship's arrival to ensure no unusual activity is

ongoing. At MARSEC 1, it is simply intended to do a sweep by the area prior to the ship approaching the points of land to ensure there are no suspicious people in the area. At MARSEC 2 and 3, the police presence should be increased to a more continuous presence so that the area is observed while the ship approaches and passes the point to ensure security on the shore side. The escort boats enforcing the moving security zone around the inbound LNG vessel would also serve to detect and deter attacks from shore side. The police officers on patrol and the crew of the escort boats must be able to communicate effectively with each other. (Section 5.4.2.4)

(19) It is recommended that a new fixed visual aid to navigation, such as a terrestrial range, to mark the transit down Desdemona Shoal Channel to reduce the chance of any navigational errors. (Section 4.3.1)

(20) It is recommended that warning system be established in the Cape Disappointment State Park which would warn visitors/employees of an LNG incident in the vicinity of the Park. This system should direct all visitors and Park employees to immediately leave the breakwater beach area of the Park and either depart the Park or muster in the North Head camp ground area. (Section 5.4.1.1)

(21) It is recommended that a "Pilot Duress" Code be established between the Columbia Bar Pilots and the Coast Guard. (Section 5.4.2.10)

(C) MOORING/MOORED

(1) Policy or guidance should be developed establishing a maximum wind speed for the mooring of LNG vessels. The "Oregon LNG Simulation Report" dated 01/03/08 (Appendix T) indicates that the steady wind limitation for docking the simulated LNG vessels was 25 knots. (Section 4.3.2 (e))

(2) In the "Oregon LNG Simulation Report" dated 01/03/08 (Appendix T), the Bar Pilots recommended that the basin dredging be extended from the proposed SW corner to the corner of the river channel in position latitude 46 11.31N, Longitude 123 54.54. The dredging issue had not been completely resolved at the completion of this

WSA. Halcrow recommends this issue be resolved before the Terminal becomes operational. (Section 4.3.2 (l))

(3) It is recommended that aids should be installed to indicate the extent of the dredged basin. The Bar Pilots recommended in the "Oregon LNG Simulation Report" dated 01/03/08 that buoys not be used because they are prone to damage by transiting vessels. (Section 4.3.2 (k))

(4) The "Oregon LNG Simulation Report" dated 01/03/08 indicates that three tugs were required to maneuver the vessel alongside the dock. The Report also noted that, "Tugs were operated at full speed on several occasions." Therefore, it is recommended that 4 tugs be available for docking the larger LNG vessels. (Section 4.3.6)

(5) Policy or guidance should be developed allowing the Bar Pilots the option of docking port or starboard side to, depending on the conditions. The Pilots felt that the "starboard side to" would likely be the most common maneuver. (Section 4.3.2 (e))

(6) A fixed security zone should be established around the LNG facility and any LNG vessels moored to it. The Security Zone around a moored LNG vessel should be 200 yards; the Security Zone around the pier with no vessel moored should be 50 yards. Two security boats should remain underway to enforce the fixed security zone if no boom is in place while the ship is moored. If there is a boom, one security boat will suffice and that boat may be underway or on immediate standby at the dock. The 50 yard Security Zone does not require a security boat underway. The security zone size should be increased to 500 yards at MARSEC Level 2 and 1000 yards at MARSEC Level 3. At MARSEC 3 the number of security boats should be increased to 3. At MARSEC 1 the boats should be armed for deterrence. At MARSEC 2 and 3, the boats should be armed for response with crew-served weapons. (Section 4.3.4) (Section 5.4.4.1) (Section 5.4.4.3) (Section 5.4.2.8) (Section 5.4.4.4)

(7) The facility should be equipped with a closed circuit television system that provides waterside surveillance. The cameras should be capable of seeing in low

light/low visibility conditions and have magnification sufficient to identify boats off Tansy Point and the nearest dock at Astoria. (Section 5.4.4.1) (Section 5.4.2.8)

(8) Two commercial tugs with full fire fighting equipment should be on immediate stand by at the dock whenever a ship is moored or underway in the immediate vicinity. These tugs could be used to either assist the ship in getting underway or actively hold the ship to the pier if the wind speed suddenly exceeded the mooring systems calculated 56 knot capability. (Section 4.3.2.2) (Section 5.4.1.3)

(9) It is recommended that a vessel management policy restricting large vessels (over 50,000 GT) from transiting past the Oregon LNG terminal at over 10 knots whenever an LNG vessel is moored at the Terminal be evaluated. The "Mooring and Berthing Analysis" conducted by CH2MHill (Appendix U) calculated that, due to the relatively large distances between the mooring and passing vessel, as well as the adequate under keel clearance at the berth, the passing vessel effects are small, at most increasing the maximum mooring line tension by 9%. However, Captain Lewin, President of the Bar Pilots Association, stated during the Risk Assessment Workshop, which was held prior to the completion of the "Mooring and Berthing Study", that the Pilots may have to slow large commercial vessels when they pass a moored LNG vessel. (Section 4.3.4)

(10) Policy or guidance should be developed requiring at least one the Oregon LNG Terminal tugs to escort all up bound and down bound ships of over 50,000 GT between buoys 27 and 31. A second tug shall be in immediate standby in the terminal basin. (Section 4.3.4) (Section 4.3.2 (h)) (Section 4.3.6) (Section 5.4.4.2)

(11) At MARSEC 2 and 3, two tugs should escort ships of greater than 50,000 GT transiting past the facility. At MARSEC 3 one of the tugs should be tethered to the stern of the passing ship. (Section 5.4.4.2)

(12) Policy or guidance should be developed requiring that at MARSEC 3 the stand by tugs should moor on the outboard side of a moored LNG ship to provide a barrier to an air threat and "USS Cole" type small boat attack. (Section 5.4.4.3)

(13) At MARSEC 3, consideration should be given to placing a POSCON team on all inbound and moored LNG vessels with a portable crew-served weapon to provide a point defense against light aircraft and small boats that may have evaded the security boats enforcing the fixed security zone. (Section 5.4.4.3)

(14) Policy or guidance should be developed to address what predictive actions should be taken by an LNG vessel if weather conditions are worsening, either to depart port if moored or to delay entry into port if it is expected that they will not be able to remain moored long enough to offload. (Section 4.3.2.2)

(15) Oregon LNG should work with the airport manager and the FAA for a determination of the ship and facility tank heights in regard to the proximity to the airport. If it is determined that they are considered obstructions, the airport master plan and appropriate publications/reference material will need to publicize the information appropriately. (Section 4.4.5 (g))

(16) An acoustical warning device such as a Long Range Acoustical Device (LRAD) should be installed at the facility to provide a verbal warning to approaching small boats that they are approaching or entering a security area. The warning device should be able to issue verbal challenges out to at least 500 yards. (Section 5.4.4.1)

(17) Oregon LNG shall conduct underwater pier inspections searching for potential explosive devices as follows:

- At MARSEC Level 2 the underwater portion of the pier shall be inspected within seven (7) days of an LNG vessel arrival.

- At MARSEC Level 3 the underwater portion of the pier shall be conducted prior to the arrival of each LNG vessel. (Section 5.4.2.8) (Section 5.4.4.4)

(D) CARGO OFFLOAD

(1) Intentionally left blank.

(2) To reduce the risk of high winds causing an accident with cargo transfer connections, policy or guidance should be developed to establish wind speed/direction

limits at which point cargo transfer operations should be halted. The Coast Guard "Chesapeake Bay Liquefied Natural Gas (LNG) Operations Plan" requires transfer operations to be halted, "… if the sustained wind speed is greater than 30 knots." As discussed in Section 3.1.2, the proposed facility's mooring rating is 56 knots so Baltimore's 30 knot criteria works with regard to the terminal's mooring rating. (Section 4.3.5) (Section 5.4.1.3)

(E) GETTING UNDERWAY AND DEPARTING PORT

(1) Policy or guidance should be developed to establish wind speed parameters for the ship remaining at the dock. The berth and mooring configuration is designed to hold the ship safely to the dock with 56 knot continuous winds blowing the ship off dock (southerly winds). After that, the ship should be expected to get underway or some other method used to hold the ship on such as tug assist. In addition, the steady wind limitations for undocking the largest LNG vessels were 25 knots. (Section 4.3.2 (f))

(2) Intentionally left blank.

(3) Until the ships have been operated in the Columbia River sufficiently that the Bar pilots are more comfortable with their handling characteristics, it is recommended that outbound ships are escorted with two commercial tugs until past buoy 10. One of the tugs should be tethered astern of the ship as was done on the inbound transit. (Section 4.3.2 (d))

(4) Policy or guidance should be developed to establish maximum wind speed and sea/Bar condition parameters under which LNG vessels would be permitted to cross the Bar departing the Port.. The "Oregon LNG Simulation Report" dated 01/03/08 recommended that LNG ships should not depart the River if winds exceed 25knots continuous (over 10-minute period). The Report also recommended not permitting vessels to depart if the swells exceed 20ft in the river entrance. These recommendations were supported by the Bar Pilots during the Risk Assessment Workshop held in Warrenton. (Section 4.3.2(b&d))

7.4 POTENTIAL IMPACTS ON THE MARITIME COMMUNITY

The largest impacts the proposed new LNG facility operation will have on the Lower Columbia River maritime community will be caused by the moving security zone around arriving LNG vessels and the permanent fixed security zone around the LNG Terminal on the Skipanon Peninsula. Members of the Columbia River fishing communities expressed deep concern that they will be disrupted and their livelihoods affected if they are required to move from their fishing grounds each time a loaded LNG ship passes by. Many of the commercial and recreational fishermen fish along the edges of the channels and a 500 yard security zone will require them to stop fishing and move out of the area until the LNG vessel has passed by.

The two most effective methods of minimizing the impact of the security zone on other boaters are to; allow flexible enforcement of the moving Security Zone during MARSEC Level 1, and to require inbound LNG vessels to transit at night (beginning in the late afternoon or early evening) during the heaviest fishing seasons, approximately June through early September.

7.4.1 Flexible Enforcement of the Moving Security Zones

Different approaches to establishing and enforcing a moving security zone around inbound LNG tankers were explored in an effort to accommodate the needs of as many waterway users as possible without lessening security to an unacceptable degree. Of the options presented in our assessment, we recommended that the current COTP Portland, OR security zone regulations for cruise ships and the security zones outlined in the Bradwood WSR be adopted for transiting LNG vessels. The current regulations, and Bradwood WSR, establish a 500 yard security zone but with a provision to allow vessels proceeding at the minimum speed necessary to maintain navigation to come within 100 yards of a passing LNG vessel. A similar Security Zone approach is currently being enforced by Sector Hampton Roads and Sector Baltimore for the Cove Point LNG Terminal. Adopting this policy does two things: It provides a consistent policy for security zone enforcement on the Columbia River and it permits fishermen fishing along the channel edge to continue fishing. Note, this level of security

is considered acceptable at MARSEC 1. However, at increasing MARSEC Levels the size and enforcement of the Security Zones must be increased.

Even with the additional provisions for enforcing the moving security zone, deep draft vessels will not be able to pass a loaded LNG ship in the Desdemona Channel. Minimizing the impacts on other deep drafty traffic on the Columbia River will require a conscious effort by the Columbia River Bar Pilots to manage the ship schedules to avoid delays. Timing ship arrivals is a routine task that the pilots are adept at and we believe they can manage the schedules to minimize any disruptions.

7.4.2 Require Inbound LNG Vessels to Transit at Night

Another effective means of reducing the impact of the moving security zones around inbound LNG vessels is to require inbound LNG vessels to transit at night (beginning in the late afternoon or early evening) during the heaviest fishing seasons, approximately June through early September. The Risk Scores calculated in Section 4 of this Report are functions of probability and consequences. (In the security scenarios probability is addressed as the product of threat and vulnerability). The potential consequence of a large LNG release is determined by evaluating where the Zones of Concern defined in the Sandia Report overlap medium and high density population areas. Normally a waterway such as the Columbia River would be treated as a low or even “not populated” area. However, during the busiest fishing seasons the Columbia River below Astoria, particularly the area around Buoy 10, can become extremely congested with sport fishermen. This type of scenario is addressed as “Transit near Areas of Heavy Marine Traffic” in Enclosure 3 to NVIC 05-05.

We addressed this situation by treating the waters around Buoy 10 as “medium density population” during the busy fishing seasons. As a result, Zone 1 overlaps a medium population density area which provides a Consequence Score of “3” from Table 4-4. The most effective means of addressing this situation is to require the LNG vessels to arrive in the evening so as to avoid the heavy concentration of fishing vessels.

A table provided as an enclosure to Governor Kulongoski Letter to the Federal Energy Commission (FERC) dated December 13, 2007 indicated that, based on boating numbers, there are three primary fishing season – Spring Salmon, Sturgeon and

Summer Salmon (Buoy #10) which extend from June through early September. The Buoy 10 Season is by far the busiest season of the year with the table showing over 20,000 boats active in August, the primary month for the Buoy 10 season. The other seasons, based on boat count, are less than half the size of the Buoy 10 season.

As discussed above, the consequence of a large release of LNG would be greatly increased if it occurred while the Columbia River was congested with thousands of sport fishermen. Therefore, LNG vessels should be required to transit the River later in the day after the majority of the sport fishermen have returned to port. However, the night time transit requirement should be enforced based on an evaluation of the fishing boat density rather than the calendar. Presumably the night time transit will apply during the busiest portions of the Buoy 10 season as this is by far the largest season. However, the fisheries should be evaluated on a season to season basis to determine if the season is busy enough to warrant nigh time transits.

8. DEFINITIONS/ABBREVIATIONS

1. **Coast Guard Captain of the Port** (COTP) - The COTP is designated by the Commandant to direct Coast Guard law enforcement activities within a designated area of responsibility. A Captain of the Port enforces regulations for the protection and security of vessels, harbors, and waterfront facilities; anchorages; bridges; safety and security zones; and ports and waterways.

2. **Columbia Rive Bar Pilots** (Bar Pilots) – The Columbia River Bar Pilots are a group of twenty pilots who provide Pilotage service for vessels in the lower Columbia River

3. **Columbia River Pilots** (River Pilots) - The Columbia River Pilots provide Pilotage services from Astoria to the upriver ports

4. **Expanded Zones of Concern** – Halcrow utilized larger Zones of Concern in the Risk Assessment portion of the WSA to address the larger size vessels planned for the Oregon LNG Terminal. The Zones of Concern developed in the Sandia Report and adopted by NVIC 05-05 are based on LNG vessels of approximately 148,000 m^3. The Oregon LNG Terminal is proposing to handle vessels of up to 266,000 m^3. The Expanded Zones of Concern used in this WSA were based on an estimated increase of 12% over the Sandia developed Zones for the 148,000 m^3 LNG vessels.

5. **Liquefied Natural Gas** (LNG) - Liquefied natural gas or LNG is natural gas hat has been converted to liquid form for ease of storage or transport. Liquefied natural gas takes up about 1/600th the volume of natural gas at a stove burner tip. It is odorless, colorless, non-corrosive, and non-toxic.

6. **Maritime Security Levels 1 – 3** (MARSEC Levels 1-3) - MARSEC levels are set to reflect the prevailing threat environment to the marine elements of the national transportation system, including ports, vessels, facilities, and critical assets and infrastructure

located on or adjacent to waters subject to the jurisdiction of the U.S.

7. **Q-MAX LNG Vessel** (Q-MAX) – The largest new class of LNG vessels measuring between 260,000 – 266,000 m^3.

8. **Q-FLEX LNG Vessel** (Q-FLEX) – A new class of LNG vessels measuring approximately 210,000 217,000 m^3.

9. **Sandia National Laboratories** – Sandia

10. **Sandia Report SAND2004-6258, "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water"** (Sandia Report) – Sandia National Laboratories Report which provides guidance on the appropriateness of models, assumptions, and risk management to address public safety and property relative to a potential LNG spill over water.

11. **U.S. Coast Guard NVIC 05-05 "Guidance on Assessing the Suitability of a Waterway for Liquefied Natural Gas (LNG) Marine Traffic"** (NVIC 05-05) - Coast Guard Circular providing guidance for the development of Waterway Suitability Assessments.

12. **Zones of Concern** – The Coast Guard NVIC 05-05 recommends that the Zones of Concern defined in the Sandia Report be applied to the length of the intended vessel transit to determine the main areas of concern along the waterway. The NVIC recommends using graphics in the WSA to depict the outer perimeter of the zones along the entire transit, in order to assess what port and community features fall within them.